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February 27, 1930

A MAJOR RAILWAY PROBLEM OF TODAY:

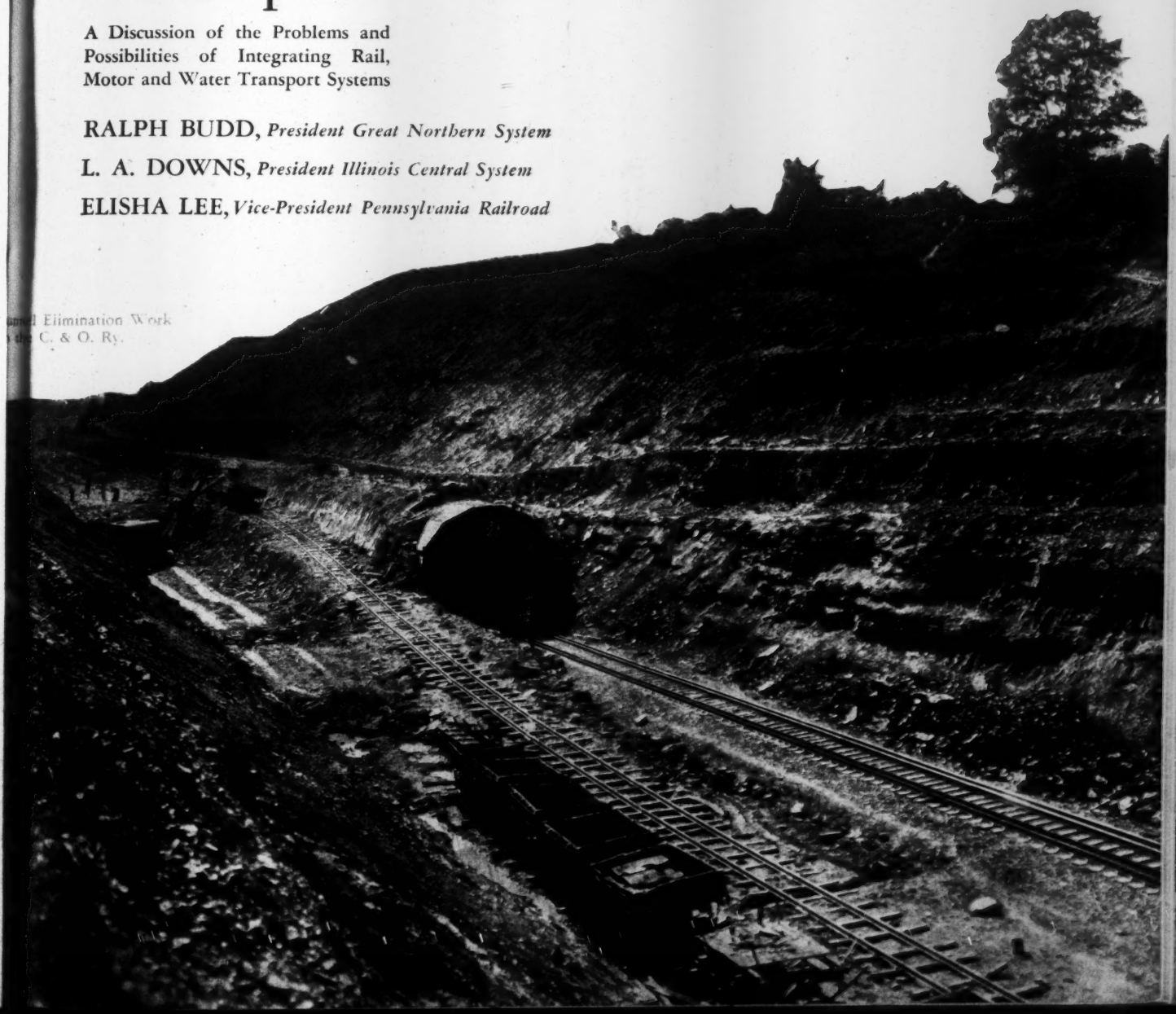
Coordinating Various Forms of Transport

A Discussion of the Problems and Possibilities of Integrating Rail, Motor and Water Transport Systems

RALPH BUDD, *President Great Northern System*

L. A. DOWNS, *President Illinois Central System*

ELISHA LEE, *Vice-President Pennsylvania Railroad*



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SHOP EXTENSIONS *at Huntington* FOR THE C. & O.

FOR the Chesapeake & Ohio Railway we have just completed the construction of large shop extensions at Huntington, W. Va., from plans prepared by the client's engineering department, Mr. C. W. Johns, Chief Engineer.

The work included large buildings to house the Pipe and Tin Shop, Erecting Shop, Wheel Shop, Heavy Machine Shop, Light Machine Shop and Mallet Shop; Boiler House Extension, auxiliary buildings, platforms, transfer tables, etc.

The shops were built in five principal steps on the site of the old shops, which were kept in operation. As the new facilities were completed—a step at a time—the old shops were removed and equipment and repair work transferred to the new buildings.

During the construction period locomotive repairs in the Huntington Shops proceeded as usual, in normal volume and at normal cost.

The work is an example of close cooperation with the engineering and operating departments of the Chesapeake & Ohio Railway.

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DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

F. E. SCHMITT, *Editor*

Volume 104 NEW YORK, FEBRUARY 27, 1930 Number 9

Co-ordinated Transport Systems

THINKING, like acting, generally goes along lines of least resistance. Thus it has been natural when considering improvement of railway transportation systems to think in terms of improving track, yard and terminal layouts, motive power and rolling stock. Thinking which has taken into consideration the possibility of discarding some of our present railroad facilities and substituting other forms of transport for them has been lacking except in a few notable instances. For that reason an attempt has been made to collect and set down together in this issue the views of practical railroad men who have projected this thinking beyond their particular field into allied fields of transportation to see wherein other forms of transport might be used to supplement that with which they are working. Ultimately such thinking will lead to a general realization that the transportation needs of this country will not be adequately met until all forms of transport are so closely integrated that each will be used to its best advantage in relation to all the others. The views herein expressed, therefore, are worthy of careful consideration as an aid in directing thinking to that end.

Adjusted Production

IS LIMITATION of production by an understanding among producers an action in restraint of trade? Under old conceptions, doubtless it was. But present-day facts show extensive endeavors to control production, with no sign as yet that government authorities regard it as objectionable. Information contained in a recent semi-official Washington publication cites half a dozen instances in which trade associations "keep in touch with inventories," or endeavor to "maintain balance between production and distribution," or act to "avoid demoralizing overproduction." Again, last week the government farm board, through one of its members, denounced overproduction of cotton and threatened cotton growers with disaster if they do not reduce their acreage for next year. These are signs of new times indeed. Yet at the same moment comes a threat that two large oil companies which propose to combine may be prosecuted, presumably on the score of restraint of trade. We have price fixing and attempted production control in agriculture, under government auspices; activity by many industries to control production, often with effective maintenance of uniform prices; a congressional bill to authorize price control through selling agreements; and open uncertainty as to the legality of business combinations which control only a small part of a large industry. To add to this confusion, the Department of Justice, which is the official prosecuting agency of the government, has for some years undertaken to pass advance opinion on proposed mergers, though it does not speak for the courts. Government policy with respect to industrial stabilization is evidently unsettled. For the present one may conclude two things: *first*, that exchange of production and market information through a voluntary trade association is innocuous until proved otherwise, and *second*, that price control is lawful when brought about by the government. These two principles do not go far. Yet if supplemented by progress in setting up rules of fair competitive practice in every industry, as the Federal Trade Commission is engaged in doing, they can bring about much fuller adjustment of our production machinery than has yet been attained.

A Slump at Saluda

STARTLING though it was at first report, the bank slump last week at the nearly completed Saluda dam now appears to be merely one of those unfortunate episodes which figure in the history of hydraulic-fill dam construction and which arise from the uncertainty as to how rapidly the washed-in fine deposit solidifies. Since no lives were lost and only a small section of bank went out, the incident is quite minor. Yet it should be studied with close attention, in view of the narrow escape from more extensive trouble, since the upstream bank had begun to slip. Knowledge of the best composition for hydraulic-fill cores is still primitive, and the same is true as to methods for controlling this composition. Soil research has a large field yet to cover before quantitative knowledge will replace the engineer's keen judgment. But, reverting to Saluda, the details of the earth-and-water outflow show excellent stiffness of the core, contrasting with the local weakness which existed at the slump. Until further data are available it must be assumed that local irregularity in sluicing procedure at a lower level set up a special weakness here, sufficient to cause the part-height trestle fill to subside, although its load was less than that at other points of the bank. All told, the happening was a mere construction accident and indicates nothing that bears disadvantageously on the adequacy of the completed dam. If anything, it emphasizes the solidity of the great structure and gives assurance that it will form an effective and stable water barrier. At the same time it points anew to the sensitiveness of hydraulic fills during the construction period, and to the need for added research knowledge.

Prospects for Hydraulic Research

A YEAR ago a bill to establish a hydraulic laboratory at the Bureau of Standards went to sleep in the files of the rivers and harbors committee of the House. A similar bill is up for consideration now, and hearings by the committee have revealed surprisingly wide support of the plan. In the light of this fact, the prospects for creation of the laboratory and for a beginning of systematic research in hydraulics are unusually bright. The value of such research is acknowledged by all. A wide range of problems in hydraulics calls for investigation,

and these problems increase daily in number and practical importance. They embrace coast protection, power development, flood hazards and streamflow; directly or indirectly they affect all aspects of shores, harbors, streams, conduits and canals. The vast amounts of money currently expended in these fields will be applied more efficiently if the laboratory is established and active research work initiated.

A Proper Start

BORINGS have been begun to determine foundation conditions in San Francisco Bay for a bridge to Oakland. They will provide essential data hitherto lacking, and will place future discussion of this much agitated project on a definite basis. For years the proponents of various schemes for such a bridge have argued on proper type of structure, best terminal locations, and probable navigation requirements, without having information needed for any answer to the question of whether a bridge could be built economically if at all. It has remained for the commission sponsored by President Hoover to insist that the horse be brought around from behind the cart. The establishing of definite information regarding the hitherto practically unknown conditions on the floor of the bay as a basis for any line of study is a satisfying return to first principles. Real progress can be made so soon as the results of the present work are in hand.

Neglected Flood Hazards

A SHARP reminder of the phenomenal flood visitation of upper New England is given by a pamphlet just issued by the United States Geological Survey, "The New England Flood of November, 1927." It brings out with abundant quantitative data and graphic description the unprecedented character of the disaster, especially in upper Vermont, where floods reached unprecedented heights and "where the loss of life and property marked the disaster as the greatest in the history of the valley." At the same time the pamphlet brings to mind the fact that nothing has been done since the flood to prevent a recurrence of the disaster or to moderate the resulting damage. Upper New England is as unprepared as it was in October of 1927. Yet this present document tells us that storms of equal or greater intensity have visited New England at intervals ranging from ten to forty years, that the 1927 flood was of the same order as others that have occurred in the same region three or four times in a century and that the future may be expected to show the same behavior of the weather. In short, the authors definitely forecast that recurrence of the 1927 disaster "seems to be inevitable unless adequate flood-control measures are provided." The warning to New England is plain; it is commended to the earnest consideration of all thoughtful citizens of the region.

The Question of Plane Crashes

JUDGING by the news of recent weeks, it is becoming a common happening for airplanes to fall on houses or city buildings. With the increasing amount of flying, this new overhead hazard will become steadily greater. Even now many people living close to flying fields, where airplanes are frequent and fly low in departing or arriving, are disturbed over the danger, and they are not reassured when they see the planes doing aerial gymnastics overhead. Will the growth of the hazard lead to impact-proof roof construction? Or, in view of the intense gasoline fire that often follows a crash, must fireproof platforms over houses be relied on for protection? Until planes become radically safer in construction and operation than now is in prospect, everyone lives under the threat of sudden death descending on him from the skies. Journals of aviation seem to take the ostrich attitude toward the menace, for they do not report or discuss accidents. There is so little regulation or policing of airplane operations that a pessimistic view of the situation is quite in tone. And unless some effective means of regulation is devised, the rather imaginative questions concerning fireproof and crashproof platforms may assume an unwelcome realism.

Underground Exploration Uncertain

LONG-CONTINUED difficulties have characterized the building of the 5-mile Tanna tunnel. The obstacles encountered catalog about all the deviltries that tunneling can muster, and the adopted construction expedients include most of the resources that engineering has developed for their suppression. No one of these resources achieved more than spasmodic victory; each succeeded for a time, then failed, again temporarily succeeded and again failed. But throughout, the builders' will to succeed continued persistent and unconquered. In the evidence of this great quality of its engineers the Tanna tunnel marks a memorable page in the records of civil engineering.

The variety and intricacy of the construction tactics and strategy need no emphasis. Of greater importance is inquiry how underground rock conditions may be predicted and appraised before the engineering plan has gone so far that there is no alternative except to push the construction attack at any cost. The Tanna tunnel is not unique in its disclosure of unpredicted rock and water conditions. The Moffat tunnel and the San Gabriel dam afford recent examples of similar surprises, and farther back the Simplon and Loetschberg tunnels contributed noteworthy experiences of the kind. The world pays heavily for its inability to foretell, even approximately, what lies ahead of the rock worker in tunnel, shaft or foundation.

So far the geologist has brought little hope to the situation. He has at most indicated only broad geological characteristics; the rock worker needs more—he must know rock conditions not only in respect to solidity but also in respect to water content and dynamic hazard from swelling and squeezing. In the latter phenomena geology offers no way to arrive at the facts, and engineering with its core-drill probing is quite as helpless. Half-mile deep drill holes into the heart of James Peak would not have told that some thousands of feet of squeezing strata existed in the Moffat tunnel. Thus the tunnel builder with all his endeavors at reconnaisance goes into action always without foreknowledge of the opposition which his forces will encounter. But while the core drill is not in all respects a certain indicator of subterranean rock conditions, it is a more useful device than the seeming reluctance of engineers to use it would indicate.

By and large, ground exploration for tunnels and general excavation is the most carelessly organized of the engineering preliminaries. There have been notorious examples in recent years where perfunctory borings, misleadingly interpreted, have led to the award by the courts

of large damages to contractors. So distrustful are experienced tunnel builders of the quality and sufficiency of the ground exploration that they will often undertake only contingency contracts for costly tunnel construction. In general, too, this important information preparatory to intelligent cost appraisal and construction planning is curtailed far below the expenditure which is reasonable in proportion to the total costs which the construction involves.

Scientific study of means for predicting underground rock and water conditions in mountain tunneling is sorely needed. The need is only a little less where rock structure has not been subjected to the distorting forces of mountain making. This year the subway builders of New York are combating unexpected rock weaknesses in the ledge that forms Manhattan Island. Pitted and cut and pierced by construction as no other rock formation has ever been, this rib of gneiss and schist has disclosed unpredicted structure that at places is multiplying the cost of tunneling. Are situations of this kind to continue beyond the control of the engineer? The question demands answer.

Economics of Railway Improvements

SOME notable articles in *Engineering News-Record* have portrayed the vast scope of the improvement programs which railroads have been carrying on in recent years. The significant characteristic of this work is that, while its immediate result is enlargement of facilities and increased traffic capacity, it was undertaken for the purpose of effecting material economies in the cost of railway operation, so as to offset conditions which tend to increase this cost.

Thus the works of improvement are important in their physical aspects as aids to transportation service, but their major importance lies in their economic aspects. It is to be noted also that the improvement programs were adopted largely in the face of unfavorable conditions as to both revenue and expenditures.

Improvements on three large Western trunk railways, as typical of lines west of Chicago, were recently reviewed by Charles A. Morse, formerly chief engineer of the Rock Island Lines. A similar review of the work on the Chesapeake & Ohio Railway, as an important Eastern trunk line, has been given by R. N. Begien, vice-president. That such improvements and policies have not been limited to the large railway systems was shown in another article dealing with the Pere Marquette Railway, by F. H. Alfred, formerly vice-president. In all these cases there is the same policy of improvement on a large scale, including grade and line revision, bridge renewal, terminal and shop enlargements, heavy track structure, signal installation and train equipment of greater power and capacity. All these developments aim both at improved service and at reduced operating expenses.

Moreover, these cases typify what is being done by many railroads which plan their improvements comprehensively over a term of years instead of simply planning for each year as it approaches. This same characteristic of modern railroad administration was pointed out recently in an address before the Railway Business Association by C. E. Johnston, president and formerly chief engineer of the Kansas City Southern Railway. With a general program as basis, the program or budget for each year is simplified, while the entire structure of the former is sufficiently flexible to permit of variation from time to time in accordance with fluctuations in financial or commercial conditions, or to meet unexpected demands and emergencies.

Major improvements have an effect far beyond that of making it possible to handle traffic to better advantage. Thus grade reductions, enlarged terminals and new signal installations not only remove physical and operating difficulties but may have the important results of allowing increased loading of trains and shortening the time of train runs. Some such cases have practically eliminated former heavy charges for overtime of train crews. In the same way more powerful locomotives haul longer trains and thus handle increasing business without a corresponding increase in the number of trains. In combination, therefore, the improved line and equipment can handle more traffic in a shorter time and at less cost. Service of this kind tends naturally to attract and develop business.

These improved conditions apply mainly to freight business, though they may have some relation to passenger business, as in more comfortable riding and in possibilities of reduced time between important points. On nearly every road there are opportunities for developing freight traffic; whether there are similar opportunities for checking or reversing the serious decline in passenger traffic during recent years still remains to be learned. As far as freight is concerned, however, it is evident that a railroad having ample, modern and well-managed facilities is in better position to render high-class service, to attract business and to handle its business economically than is a road whose facilities are overtaxed and which is conducted on a policy of keeping expenditures at the lowest limit.

Costly passenger stations—that large item in modern railway construction expenditure—may seem at first sight to be outside the field of "economic" improvement, since they have little effect in developing traffic, present little chance of return on the investment and are mainly publicity factors. But in many cases the new station is only one feature of a revised terminal layout replacing outgrown and inadequate facilities which are in themselves uneconomical. Then the improved conditions of the terminal as a whole may largely offset unproductive expenditure on the station itself. Beyond this there is the opportunity, now being realized to an increasing extent, of producing revenue from the construction of air-rights structures on the station or terminal site.

Experience has shown that even in periods of financial and commercial stress it is often wise and economical to spend money liberally on improvement work, provided the spending is on a definite program and under proper control. The basis of such a broad policy is that the money spent will produce results in direct reduction of operating expenses, in increased value of the railroad property and in improved service, all tending to improve the railroad as a transportation machine and to attract additional business.

Spending in an "easy time" period is not a difficult matter. But to spend liberally yet wisely in hard times calls for courage and foresight. It necessitates carrying conviction of the prospective ultimate results to the minds of those who hold the pursestrings and who may be inclined to tighten them when revenue falls off or the business horizon is cloudy. It is in situations of this sort that the engineer has an opportunity to display an ability founded on his training in economic principles as well as in the technical features of his professional training.

One of Today's Railway Problems:

Co-ordinating Various Forms of Transport

A Discussion of the Problems and Possibilities of Integrating the Rail, Motor, Water and Air Transportation Systems

AN IDEAL TRANSPORTATION SYSTEM would move freight from origin to destination by the best route and medium—either the cheapest or the fastest, depending on whether time or money were the governing factor. Freight would go by rail, truck, barge or even airplane, or by a combination of two or more, at the discretion of the transportation company in charge of its movement. From the time the goods left the shipper's door until they reached destination, the means of transport and the route would be the concern of the transportation company which contracted for the movement. Similar flexibility would characterize passenger transportation, except that choice of alternates would rest with the passenger.

Ideals, however difficult to obtain, serve a useful purpose as an object to aim at. So this ideal of co-ordinated transport points the way for a new trend of thinking in the railway field. A few men have already begun to think of transportation in terms of the ideal just indicated. They have projected their thinking beyond the limits of their own field and past barriers heretofore considered insurmountable. In some instances that thinking is beginning to have its effect upon the plans of the organization. Some railway companies are beginning to think of themselves as transportation, not railway, companies.

Such a broad view is stimulating. It should be passed on to others for study and amplification. To that end engineers in close touch with these developments were asked to state their views on different phases of the subject. The views of some of them are given in the following pages. Elisha Lee expresses the views of the Pennsylvania Railroad on transport co-ordination in general; Ralph Budd speaks from the point of view of one who has already gone far toward integrating rail and bus service in the transportation of passengers; L. A. Downs discusses the difficulties in the way of making our barge lines a part of a general transportation system. Finally, there is given an editorial summarization of the views of a number of men on the possibilities of motor trucks as an adjunct to railway services and as a means of expanding barge-line services on our inland waterways.

These discussions are notable not only because they clarify the view of what constitutes unified transportation systems but also because they foreshadow coming developments. The future seems destined to witness momentous changes in the management of our transportation service. —EDITOR.

The Future of Railways in Relation to Other Forms of Transportation

BY ELISHA LEE

Vice-President, The Pennsylvania Railroad, Philadelphia, Pa.

ALTHOUGH our national transportation situation is being modified greatly by comparatively new factors, I was never more optimistic than I am today concerning the future of American railroads, nor have I known a time when so many constructive plans were afoot to make our railroads of greater and more efficient service to the country.

The extent and quality of transportation is a trustworthy index to the social and economic welfare of any nation. Since transportation during the larger part of the last century has meant to us steam railroad service almost exclusively, the importance of the role played by railroads in the settlement and development of our country up to the opening years of the present century can scarcely be exaggerated.

Even in the last 25 years, during which the motor vehicle and the airplane have appeared as commercial carriers, it was the railroads that chiefly sustained our expanding prosperity. Without meaning to discount in any way the present or potential utility of motor vehicles or airplanes, it is a fact that railroads remain today the backbone of our transportation system and seem destined to continue indefinitely to occupy that position. In fact, our further development will place a constantly heavier burden on the railroads while at the same time the nation is making full use of all other forms of transportation. It is reasonable to expect that our future need for low-cost transportation will be so great that it can be supplied only by a thoroughly co-ordinated national system of transport in which the railroad, the motor vehicle and the airplane, each working smoothly in its particular field of greatest usefulness support and supplement one another.

Certainly no other agency is better qualified than the railroads to lead the way toward this achievement, and acceptance of the challenge thus presented should be regarded by the railroads as a duty as well as a privilege.

Railroads, intending to provide adequately for the progressive development of their service, can no longer confine themselves to rail transportation alone. Recognizing this situation, some of our railroads within recent years have entered also the business of transporting passengers and freight by motor car and airplane. As a result the term "railroad" no longer properly describes the transportation service which the more progressive railroads are offering to the public. They are no longer merely railroads; they are transportation companies.

This is in accord with the most enlightened view of the railroads' responsibility to the public. Railroads must give the people the kinds of transportation they want and that their varying needs and circumstances require.

Since the Pennsylvania is generally recognized as one of the leading exponents of this new theory of railroading, perhaps I may with propriety use its activities to indicate what progress is being made by the movement to co-ordinate trains, motor cars and airplanes.

The rise of the motor car has been one of the most

spectacular developments of the present century, and its effect on rail transportation has been marked. Motor vehicles are supplying an important auxiliary service which in many cases the railroads could with efficiency and economy and in the interest of the public incorporate into their own operations.

In recent years a wider recognition of the harmonious and complementary character of the transportation service supplied by railroads and motor vehicles has also emerged from a quarter of a century's experience with the automobile. Co-ordination of rail and highway transportation, eliminating the wasteful competition which has been harmful to both in the past and not in the best interest of the public, is now under way.

We have organized a subsidiary corporation, the Pennsylvania General Transit Co., all the stock of which is owned by the Pennsylvania Railroad. Using it as a medium, we have obtained, and are obtaining, certificates of public convenience to operate bus lines wherever such step is necessary. In addition, we have acquired outright approximately one dozen companies already operating chiefly over routes of local or comparatively short-distance character. We have also acquired a 75 per cent interest in the Peoples Rapid Transit Co., operating between Philadelphia and New York, Philadelphia and Atlantic City, Philadelphia, Baltimore and Washington, etc. These lines represent a total investment of about $2,000,000 with 139 buses, carrying more than 4¼ million passengers a year.

Of larger scope, however, are the relations, both operating and financial, which we have formed with a much more extensive enterprise, the Greyhound Lines of Indiana. This organization handles our bus transportation between the Mississippi River and the Atlantic seaboard—substantially the territory traversed by our rail lines. It does a business of more than $7,000,000 a year, operates 425 buses, carries 3,000,000 passengers annually, for the most part over long-distance hauls; and rolls up 19½ million bus-miles.

Thus we have a bus organization of no mean proportions, even by comparison with the statistics of railroad financing and operation. We regard it, however, as only a beginning, and we foresee a far greater future for the co-ordination of railroads and bus service.

Our plans for future bus expansion will include the sale, over certain routes, of through tickets covering joint rail and bus journeys, the operation of buses to perform the functions of local train service over certain stretches of main or important lines where this is desirable in order to speed up the operation of through trains, and also, where conditions warrant, to take the place of passenger train service on branch lines of light traffic.

In addition, we intend to utilize bus lines more fully than heretofore as feeders for our established rail service and to extend or improve bus transportation in territory not conveniently served by existing railroad facilities.

Motorized Freight Service

Now let us turn to the motorized freight service. The Pennsylvania has been a pioneer in adapting the motor truck to railroad use. Its first motorized freight line was established seven years ago, but at present it has 51 motor truck routes in operation, representing 4,084 miles of line. The daily average tonnage handled by the motor truck routes is approximately 705 tons. The number of stations thus served by trucks is 708, and 68 trucks, 29 trailers and 4 tractors are used in this service.

Our first motor truck line for the transportation of less-than-carload freight was established in 1923 between one of our stations in the southwestern part of Philadelphia and Wilmington, Del. One truck now performs all the service, and two freight trains, one in each direction, have been eliminated.

In using motor trucks for the way freight service the vehicles employed merely go from station to station, picking up and putting down the packages on the station platforms. As far as the shipper and receiver are concerned, the trucks supply exactly the same service as the freight trains they replace.

The use of trucks in terminal work is also rapidly progressing in the Cincinnati terminal district, and between St. Louis and East St. Louis the Pennsylvania Railroad participates with all other roads entering the district in effecting the interstation and interline transfer of all freight under trucking contracts. Similar arangements are also in operation, but confined to interchange among Pennsylvania Railroad stations only, at New York, Philadelphia, Detroit, Toledo and Baltimore, where 13 tractors, 6 trucks and 39 trailers are in use.

In this terminal district interstation work, including participation with other lines, a total of 103 tractors, 309 semi-trailers, 15 chassis and 220 demountable bodies are devoted exclusively to railroad use. In addition, a large volume of freight is interchanged by truck, under contracts based on weight handled and not calling for exclusive use of the vehicle.

The use of motor trucks, in co-ordination with the railroad, unquestionably reaches its highest economic development in collection and distribution within terminal zones, thus making possible a complete through transportation service from the door of the shipper to the door of the consignee. Complete integration of motor truck and railroad facilities is thus provided in the container car service now offered over certain routes by the Pennsylvania Railroad, as well as two or three other roads. In the last fifteen months container car traffic handled by the Pennsylvania Railroad amounted to 96,401 tons.

Airplane Service

Although we have not had so long experience with the airplane as a commercial carrier, it is now generally accepted as a practical means of travel, and commercial transportation of passengers as a purely private enterprise has made an auspicious beginning in the country. In fact, its development along sound and conservative lines has reached a point sufficiently advanced to justify the prediction that the next four or five years will see commercial aviation permanently incorporated into the mechanism of our national life.

Our company was the first railroad in America to register officially its confidence in the future of commercial flying, and our recognition was accorded in a highly practical form—by backing with our money and prestige the best-planned and most completely organized rail-air line in the world. I refer, of course, to the Transcontinental Air Transport-Maddux Air Lines, in which the Pennsylvania owns a substantial stock interest.

The pioneer 48-hour rail-air service between New York and Los Angeles was established by the Transcontinental Air Transport, Inc., last July and has been in regular operation since that time. Perhaps the outstanding feature of this service is that it permits long-

distance travelers to enjoy the high speed of planes in daylight hours and comfort and convenience of Pullman cars at night.

On the westward trip the service consists of a night rail journey on the Pennsylvania's "Airway Limited" from New York to Port Columbus, Ohio; a flight the next day to Waynoka, Okla.; the second rail journey over the Santa Fe during the night to Clovis, N. M., and another flight the second day to Los Angeles. As a result of a merger in November of Transcontinental Air Transport and the Maddux Air Lines, two-day service is now being provided between the Atlantic seaboard and San Francisco, San Diego and Agua Caliente, Mexico, in addition to Los Angeles.

In the eastward service, planes start from San Francisco and Los Angeles and meet at the Barstow (Calif.) airport. At this point passengers from San Francisco transfer to the plane from Los Angeles to continue the first day's flight to Clovis.

The total cost of the rail-air trip from New York to Los Angeles is now $159.63, bringing it within the reach of the general public. Recent reduction of the rail-air tariff to its present level has greatly stimulated the volume of traffic.

Wihout entertaining any illusions concerning the commercial limits of airplane transportation, one can say very definitely that it has a promising future and that it will be a considerable factor in the further progress of our civilization. Just what will be its ultimate status in the field of sober utility and how its usefulness to mankind will compare with that of the railroads and the motor car are questions that only long experience can answer.

I am convinced, however, that rail-air service is here to stay. It rests on thoroughly sound foundations and meets genuine economic and social needs of our people, and I feel that these needs are certain to grow as time passes. Rail-air transport doubtless will remain the framework around which all other forms of commercial aviation will expand.

The most auspicious thing about the development thus far of the airplane as a commercial carrier in this country is that we have started with co-operation between railroads and air lines. That is getting off on the right foot. It means that we have reached the point where the idea of co-ordinated transport is being taken as a matter of course by everyone concerned, including the public.

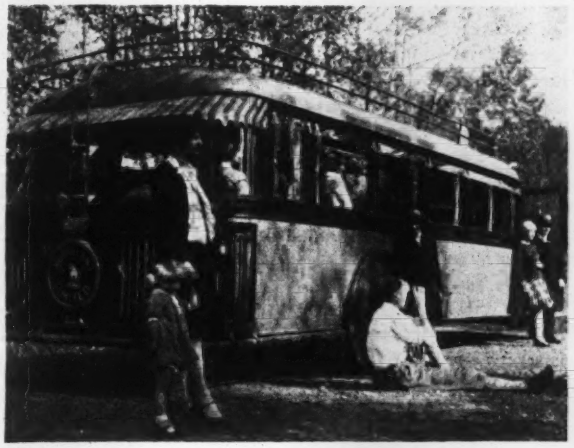
Railways and Bus Transportation

By Ralph Budd
President, Great Northern Railway

THE story of declining railway passenger revenue since 1920 and the growing use of the highway probably is better told by a few figures than by words. For that reason I think it well to call attention at the outset to the accompanying tabular statement covering the continental United States. If through and local railway travel could be shown separately, the former would show a slight increase, while the latter would show a decrease greater than the figures given in the table, which are the totals for all passenger trains on Class 1 roads. The longer average journey made in 1928 than in 1920 reflects this fact.

That there has been a general shift of travel from the railway to the highway is too well known and understood to require any argument. It is an action of the public taken for reasons of personal preference and must be accepted. The figures given show that the shift has been mostly to private automobiles and to private buses, such as those handling school children, hotel patrons and industrial employees. The amount of travel by the common carrier bus, however, is sufficient to make it a subject for consideration by railway managements having in view the adoption of a policy for dealing with the problem.

DULUTH AND TWIN-CITIES BUS CROSSING THE MISSISSIPPI



TOURING BY BUS

For several years the railways ignored the bus as a competitor, railway managements probably considering it a passing fancy of public favor. Judging by the short period of popularity of the jitney buses, which were numerous in many localities following the World War, it seemed likely that intercity buses soon would go the same route and disappear. It is probable that they would have done so, to a large extent at least, had it not been for the fact that in 1925, for the first time, manufacturers began building buses that were designed especially for passenger travel. This type, seating up to 34 people, quickly replaced the old modified truck type which provided most uncomfortably for about twenty people.

Another thing that seemed likely to limit the extent of bus competition was the lack of regulation, which accounted for the excessive competition as to both rates and service and the consequent inadequate earnings, which resulted in poorly maintained equipment. Their lack of prosperity, however, did not terminate the competition, for when one "fly-by-night" operator wore out his equipment two others seemed to take his place. The low fares which characterized this kind of service of course constituted the worst possible competition for the railways affected. State regulation has improved this situation in most instances where the runs are intrastate, but as yet there is no federal law to control highway competitors in interstate service. Such a law is needed from several standpoints; the public is as much interested in it as the bus operators and the railways.

Following the inauguration of state regulation, some railways undertook to stabilize the bus business in the localities where they were most affected. In this way, shortly after the enactment in 1925 of the Minnesota law regulating common carrier highway vehicles, the Great Northern Railway became interested in the buses operating in the territory tributary to the Twin Cities (St. Paul and Minneapolis) and comprising the entire State of Minnesota. The Great Northern's mileage in Minnesota is almost twice that of any other road and therefore it was more concerned in the loss of railway passenger business to the highways than any other railway. The fourteen bus companies then operating in this territory were nearly all in financial difficulty and had been so for some time. They were using uncomfortable, unreliable and unsafe equipment. Their runs were following each other and the railway trains at very close intervals and leaving wide time gaps between those concentrated trips.

These various bus companies were acquired by purchase and were consolidated into one company by the Great Northern, the Northland Transportation Co., which was the most successful one purchased, being used as the corporation to take over the others. The result of this consolidation has been satisfactory from the beginning and has met with public approval and patronage. The Northland company now operates 150 buses over 3,000 miles of highway and handles more than 3,000,000 passengers annually. Dissatisfaction with the old conditions and desire to improve the situation has resulted in cordial co-operation between the Minnesota Railroad and Warehouse Commission, the Northland company and the various railways, with the result that many railway passenger trains which had become unprofitable have been discontinued, schedules rearranged, and the bus and train schedules so correlated as materially to improve passenger service as a whole.

The same thing has been done elsewhere. In some other localities where it has been impossible for a railway to organize the bus properties into a company which the railway owns, responsible independent companies have been formed in which the railway company has a minority ownership but an influential voice in policy and management. This form of railway relationship has become quite extensive and now is more or less prevalent on the coast-to-coast system operating between New York, Philadelphia and California, with a line extending north to Portland, Ore. The Great Northern Railway adopted this plan of relationship last summer and sold its control of the Northland Transportation Co.

TRANSPORTATION DATA

	1920	1928
Railway passenger revenues	$1,285,395,081	$898,951,220
Automobiles	8,225,859	21,379,125
Common carrier buses	10,000	44,486
Private buses	5,000	41,150
Passengers carried 1 mile		
In railway trains	46,847,534,000	31,538,130,000
In automobiles	125,000,000,000	320,000,000,000
In buses	2,000,000,000	10,050,000,000
Average length of journey on Great Northern Railway, miles	80	147

As a part of the transcontinental system, the local bus operations derive distinct benefits from the through bus lines. In addition to these traffic advantages from connections, there is the advantage of relieving the railway management from the duties of bus management and the advantage of having a highly specialized bus personnel devoting its whole time to that business and therefore developing ideas and methods in respect of service, equipment, maintenance and operation which could not be developed if handled by railway officials who already are too busy and who by training and tradition almost certainly would have an unsympathetic attitude toward the bus industry. A collateral feature of this relationship is an agreement whereby the Northland Transportation Co. will provide bus service wherever the Great Northern Railway so desires and whereby, should the service be unprofitable, the Great Northern will pay the cost of service, including a small charge for overhead. Such an arrangement makes it possible to substitute buses for unprofitable trains where the former are suitable and to do so at the minimum of cost.

In some parts of the country there is being waged a bitter and costly fight between railway-owned buses and those independently owned. In still other places the

competition is between bus lines owned by one railway and those owned by another railway, with privately owned lines making the fight three cornered. Heavy loss of money and unsatisfactory service are inevitable under these conditions, which must be regarded as unfortunate and more or less temporary. This condition seems also to demonstrate the impracticability of each railway company having an extensive bus line of its own and to suggest that minority ownership in bus companies by railways offers a reasonable way for participation in bus activities in the territory served by the various railways without increasing wasteful duplication.

Railway ownership of buses began in 1924 with the Boston & Maine Railroad and has increased steadily ever since. According to last reports, there are now approximately 2,400 railway-owned buses out of a total of 44,486 common carrier buses. In addition to the 2,400 railway-owned buses just mentioned, railway companies own minority interests, but not control, in extensive bus operations throughout the United States.

Out of it all there seems to be emerging the conviction that regulation of state and interstate buses is necessary in the public interest. With regulation must come control of rates as well as service and the elimination of ruinously excessive trips injudiciously scheduled. The railways required regulation to protect one another from the vices of earlier days, among them being the cutting of rates and giving of rebates. The same protection is necessary to insure to the public the best class of service and a continuation of good service on the part of common carrier vehicles on the highways. There is no doubt in my mind that such regulation is coming. With it will come a correlation of highway bus schedules with those of railway passenger trains. This arrangement will give the public the maximum of service at the minimum of cost and at the same time will enable the railways to make substantial economies by removing unprofitable passenger trains and by being protected to the extent of having rational rates and schedules maintained by their competitors on the highways.

Railways and Waterways in Transportation System

By L. A. Downs
President, Illinois Central Railroad System

PUBLIC opinion is calling more and more clearly for co-ordination of the various agencies engaged in the work of transportation. That demand represents sound public policy. The aim of all means of transportation should be to give the public the best and cheapest service possible. Whatever defeats that aim is wasteful and should be avoided.

In considering the relationship between rail and water transportation, we must first recognize the fact that history records no instance of long-continued competition between the two. Competition is a matter of both rates and service, and a competitive adjustment of rates and service is extremely difficult to maintain between different methods of transportation. The inevitable result of such attempted competition in the past has been that one demonstrated its superiority—in rates or service or both—and got the business, while the other retired from the field.

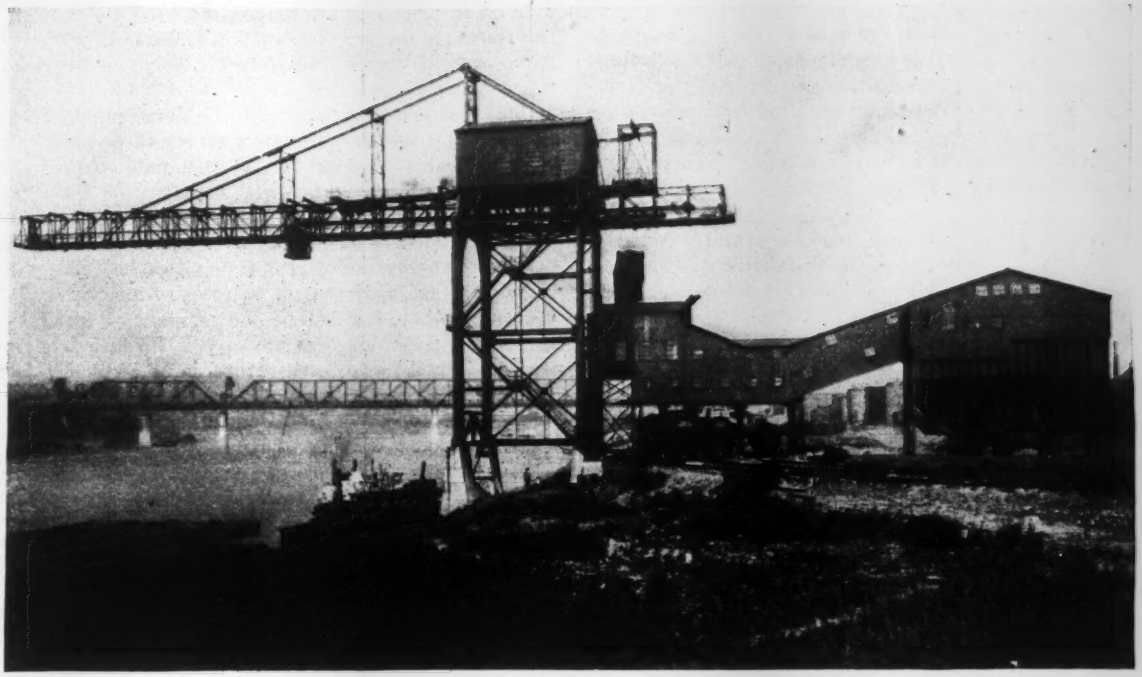
In some cases the railroads were defeated; in others, the water carriers. In the movement of iron ore from the upper to the lower ports of the Great Lakes and the return movement of coal, the lake carriers demonstrated their superiority and took the business. The railroads stopped trying to provide facilities and retired from the field, with the result that this movement is suspended during the period each year when the Great Lakes are closed to navigation. On the other hand, as the railroads developed, there was once a brief period of competition between this new means of transportation and the steamboats that were being operated on the Mississippi and other rivers. The competition ended with the railroads getting the business and the steamboats retiring from the field. In the former case the railroads continued to function for the handling of iron ore and coal at both ends of the lake route and for general service all the way around the lakes. In the latter case, few vestiges of the steamboat era survived.

Such experiences as these indicate that extinction, not co-ordination, is the natural process where the same sort of traffic in the same territory is sought by both rail and water carriers. To the extent that a demand may exist for different classes of service which neither competitor can satisfactorily and profitably provide in their entirety, there may be possibilities of successful co-ordination within the same territory. Otherwise there must be a give and a take—an extinction here and a counterextinction there—until the field is divided and another sort of co-ordination thereby attained.

Any desired co-ordination of rail and water transportation, therefore, must be worked out by assigning each service to that means of transportation which can provide it at the cheapest total cost to the public. The soundness of that principle ought to speak for itself. Spending money without a constructive plan is almost invariably wasteful, and that applies to money spent for transportation development just as much as it does to everything else.

I purposely say "at the cheapest total cost to the public" instead of "at the cheapest rates," because not all carriers charge rates that cover the total cost of service, as the railroads do. Out of the rates collected by the railroads are paid the expenses of operation and maintenance, taxes and the hire of property. Out of the rates collected by carriers on inland waterways are usually paid only the expenses of operating and maintaining the equipment. Most of the other expenses are paid by the taxpayers; not merely the taxpayers adjacent to the waterways but those all over the country. For example, the taxpayers pay for building and maintaining canals and connecting channels and for constructing, maintaining and operating locks and dams and other regulating works to make the watercourses navigable. In addition, where the government is the operator, the taxpayers provide the equipment and also make up for the taxes that are not collected and for the deficits that are incurred. Successful co-ordination of rail and water transportation must recognize this difference in who pays the bill.

Successful co-ordination of rail and water transportation must also recognize the differences that exist in the quality of service performed by the respective carriers.



CO-ORDINATING WATER AND RAIL TRANSPORT IN COAL HANDLING
Coal being brought to Cincinnati by barges and transshipped to cars.

There is an old maxim to the effect that the best is usually the cheapest notwithstanding its greater original cost, and this often proves to be true in buying transportation service. An illustration in the field of transportation is the use of express service as compared with freight service in shipping Louisiana strawberries to Northern markets. The cheaper service is always available, but it is little used. Shippers are glad to pay more for the better service.

Failure to consider this difference in quality of service is responsible for some misleading claims that are made as to the savings derived from the present use of inland waterways. It is a common practice for carriers on inland waterways to make their rates approximately 80 per cent of rail rates on the same traffic between the same points. Many explanations of this practice are given, but the most logical one is that a 20 per cent reduction in the rail rate is necessary in order for the water carrier to get the business. In other words, the service provided by the water carrier is worth only 80 per cent as much to the shipper as the service provided by the rail carrier. If this is true, there is no real saving here. Real saving comes from paying 80 cents for something that is worth a dollar, not from paying 80 cents for something that is worth only 80 cents.

Notwithstanding the fact that the railroads once demonstrated their superiority over the steamboats operated on the rivers, the feeling has long prevailed in some quarters that it was not a fair test. The repeated demand for another test led to the barge-line experiment which was launched by the United States government in 1918 on the lower Mississippi and Warrior rivers, which has since been extended to the upper Mississippi River and which is now being discussed for extension to the Missouri and Illinois rivers.

Some may ask: "Why do not the railroads take over these barge lines?" As an academic matter, I should say that the railroads ought not to be barred, as they now are, by law from operating barges on the river if in so doing they can provide cheaper service. But, as a practical matter, there is an important question to be answered before any railroad would attempt to operate on the river. That question is: "Will it pay?" The eleven-year-old Mississippi-Warrior experiment is expected to provide the answer to that question. Thus far the barge lines have succeeded primarily in demonstrating their ability to get traffic in certain commodities between certain points at rates that are approximately 80 per cent of the rail rates on the same commodities between the same points. The business-getting ability of such rates has been fairly well demonstrated. But can the carrier make money on them if all its proper costs are taken into consideration?

Repeated claims are made that the barge-line experiment as a whole is a demonstrated success. I believe anyone will concede its success as a government undertaking, favored by freedom from taxes and from the necessity of producing reasonable earnings for the owners and backed by the power and prestige of the United States. But can it demonstrate its financial success on the basis of operation as a private undertaking? That, seemingly, remains to be seen. The makers of the experiment have repeatedly given assurance to a public opposed to government ownership in business that the operation is merely an experiment and that the property will be disposed of when the experimental stage is past. Yet the date for the termination of the experiment has never been set. The barges are unsold.

I suppose a good many persons wonder why some railroad like the Illinois Central, which operates in this river territory, does not buy out the barge line. Railroads are straining every nerve to economize, and economy should be the outstanding virtue of barge-line service. There are two principal reasons why this opportunity

has not been seized. One reason is that the law strangely forbids it; but the primary reason is that no adequate proof has been given that it would pay. Added to these objections, of course, is the sincere doubt that the movement for the development and use of inland waterways between points already capable and adequately served by rail carriers is based upon sound reasoning. Three arguments are usually advanced in favor of the inland waterways.

One argument is that our growing country requires the use of inland waterways to relieve the railroads of traffic they cannot handle. That argument came into greatest use about the time the railroads, starved by years of inadequate earnings, were laboring under the strain of traffic growing out of war-time conditions. Railway men themselves were having much to say about the necessity of increasing the nation's transportation facilities. Since then, however, those facilities have been increased enormously, the railroads having spent in the last ten years more than eight billion dollars for improvements and additions. New tracks have been laid, larger locomotives and cars put into service, signals installed, grades reduced. This ten-year expansion cost nearly half as much as had been spent upon the railroads in the previous 90 years.

The result is that the railroads today are more than adequate to take care of all the transportation needs of the country. But someone may say: "How about the future? Our country is growing." The answer is that it has grown in the last decade, during which time the railroads have staged a comeback from a condition of inadequacy to one of complete adequacy. That remarkable comeback is proof of the fact that the capacity of the railroads has no physical limitation. Provided earnings are such as to stimulate credit, they can expand their capacity indefinitely.

The second argument is that the development of transportation by inland waterways serves to depress railway rates. That argument, too, is unsound. Railway rates are regulated by governmental authority on the principle that the railroads have to pay their own way—in other words, on a balanced budget basis. Since rail-water competition usually results in a division of business and not merely in the readjustment of rates to meet it, as I have indicated above, the loss of one segment of traffic by the railroads necessitates increasing the income from other traffic. The net result, therefore, is no reduction in railway rates as a whole. Indeed, it may mean increases in the same territory or elsewhere on traffic which the water carrier is unable to handle.

That leaves only the price argument—namely, that it is cheaper to perform transportation service on water than on rails. It is—at some places and for some things. It is on the Great Lakes for the movement of iron ore and coal. But is it cheaper on the Mississippi River for these or other things? Many persons honestly believe it is. Railroads are still waiting to see some element of proof.

The transportation history of our country makes it clear that the railroads are and must continue to be our main reliance for transportation. They go everywhere and carry everything. Any service that desires to be co-ordinated with them ought to be required to demonstrate its value both in quality and in price.

Motor Trucks in Transport Service

MOTOR trucks as an auxiliary to railway transportation have come into wide use within the past few years. It may well be said that an appreciation of their possibilities in such service is one of the few valuable outgrowths of the World War, for many railway men in the army service first saw how adaptable they were to the movement of war materials and supplies in advance of the standard-gage railheads at the front in France and for the movement of both men and materials over routes where no rail line was available or where the rail lines were already overloaded. After the war the Pennsylvania Railroad, under W. W. Atterbury, former director of general transportation of the American Expeditionary Forces, began a study of the possibilities of motor trucks in railway service in this country and within two or three years commenced putting them into service. Since then, the number in service has increased greatly. Figures given by *Railway Age* place the 1929 total at 5,900 trucks in operation on 55 railroads.

Truck service on railways falls into two general classes, (1) terminal service between outlying railway yards and so-called inland or off-rail terminals at large cities, and (2) station-to-station service parallel to busy main lines. There are, of course, variations of these services such as store-door delivery, which has been tried with a considerable amount of success in a few places.

New York City, with most of its railway lines terminating on the mainland in New Jersey, is the best example of the use of trucks between outlying rail terminals and inland terminals or warehouses. About the time that the Holland tunnel under the Hudson River was opened, the Erie Railroad began operating trucks between its rail terminals in New Jersey and terminal warehouses in New York City. Similar service was subsequently undertaken by other railroads, and it may be expected to increase greatly with the construction by the Port of New York Authority of the first of a series of large inland terminals for the joint use of all railroads. Similar conditions have been met in a somewhat similar way in other cities, notably St. Louis.

In main-line service, trucks are being used extensively to release railroads of the necessity for operating a way-freight or pedler service. On any railway other than a single-track line with a limited amount of business the operation of a way freight—requiring the frequent use of crossovers and the blocking of all the track—is very costly in the matter of delays to through freight. Wherever a highway runs roughly parallel with the railway, as is the case in most settled communities, this business can be handled easily and expeditiously by trucks running along the line from station to station. No direct savings in cost can be shown by this method, but the indirect savings are large.

Trucks have been employed as a substitute for way-freight service on branch lines, but they have been found to have limitations not applicable to buses in similar service. Buses have in many instances completely supplanted passenger trains, but trucks cannot replace freight trains where there is any local switching of industrial tracks to be done. Consequently it is cheaper to continue to op-

erate way freights for both the local station-to-station freight service and the switching.

Few railroads carry on truck operations directly. They conduct them by contract with outside trucking companies or through subsidiary companies specializing in truck operations. This method not only places the operation of the trucks under the supervision of men experienced in that class of work but also relieves the operators from some of the requirements of railway labor laws—laws which were not intended to be applicable to motor service conditions but which would have to be observed were the operations carried on directly by railroad companies.

Future of Truck Operations

There is every reason to believe that we are only on the threshold of the application of trucks to a general transportation service, especially in connection with railway container cars and in terminal area freight movements. Just now developments in the container-car field have been checked by uncertainty as to what future rates will be. If the railroads are permitted to charge rates bearing a close relation to the cost of the improved service, they may be expected to continue the experiments which have brought about the present developments in container cars.

The same is true of the use of trucks in terminal service. If railways are not unduly restricted by attempts to separate terminal costs from line-haul charges, they will take advantage of every opportunity to reduce the total cost. Thus the near future may see the abandonment of costly rights-of-way and terminals near the center of our larger cities and their replacement by off-rail terminal warehouses served by trucks from outlying yards, or even by store-door deliveries of much of the freight.

Reduction of Traffic Congestion

Co-ordination of rail and motor-truck services in freight handling has many possibilities for relieving street traffic congestion. For example, the use of sealed freight containers which can be moved from the shipper's warehouse to the railroad yard by truck, placed on a container-car and moved by rail to a distant terminal, there to be transferred to truck for movement to the consignee's warehouse, offers one important means of relieving street traffic congestion. With proper space outside the shippers' warehouses for the storage of containers, they can be picked up and delivered after hours or at night when streets are not congested. Heretofore the cost of maintaining a staff for the reception of night deliveries of freight has prevented the wide use of night deliveries to the relief of street congestion. Of course small shipments of freight will still have to be delivered in the daytime, but the concentration of such freight in local union terminals, as is to be done in New York under the auspices of the Port Authority, will make possible the movement of much of such freight to and from the union terminals to the freight yards at night.

Another factor not to be overlooked is the increasing congestion on rural highways, which is bound to bring to the fore the question of the continued use of the highways by large and relatively slow trucks to the detriment of the faster-moving passenger vehicles. If this condition brings about an increase in taxes upon truck operations, a very definite check will be put upon the long-haul freight-trucking business, which might include the station-to-station business of the railroads. On the other hand, if it brings about the construction of independent highways for trucks, as has been proposed very seriously in New England, an impetus may be given to the movement of station-to-station truck haul by railroads.

Trucks as an Aid to Barge Lines

The future possibilities of trucks as an adjunct to barge lines operating on our inland waterways have been given scant consideration up to this time, chiefly, it is to be supposed, because the principal commodities handled on inland waterways are bulk materials like coal and iron. Nevertheless, an increasing amount of package freight is being so handled, and it is reasonable to suppose that more would be carried by water if a store-door service for the collection and delivery of freight were made a part of the barge service in the larger cities along the waterways. The service might even be extended through a limited zone back from the waterways, by the establishment of inland terminals to and from which consolidated shipments would be moved by truck. Containers such as the railroads employ in their container-car service would further extend the field of the barge lines. The ordinary type of wharf crane with which many barge terminals are equipped is easily adapted to the transshipment of containers. With barge and rail containers made interchangeable, the field of both might be greatly extended.

No hard and fast rules regarding the field of the various kinds of motor-truck service can be laid down, because local physical conditions and state regulations are governing factors. In one state, where load limits are liberal and valuable manufactured products are shipped in large quantities, a long-haul truck service might be found highly profitable. In a state having low load limits and producing only bulky commodities a similar station-to-station haul might be found very unprofitable. If legislative restrictions can be kept down to the minimum required for public protection, each locality will be able to work out its own means of making the most of the advantages offered by trucks in handling the freight peculiar to that region.

Increase in Traffic on Staten Island Bridges

Traffic over the two Arthur Kill bridges between Staten Island and New Jersey in the first eighteen months of operation totaled 1,783,487 vehicles, according to figures made public recently by the Port of New York Authority. In the last six months of 1929 travel increased 25 per cent over the corresponding period of 1928. Gross receipts since the opening exceeded $1,000,000. The Goethals bridge, between Elizabeth, N. J., and Howland Hook, Staten Island, has been patronized by 970,782 vehicles, and the Outerbridge Crossing, between Perth Amboy, N. J., and Tottenville, Staten Island, by 812,705.

Wide Interest in Lighting Problems

During the eight months since the opening of the Westinghouse Lighting Institute in New York City on June 1, 1929, attendance at the exhibits and demonstrations in the institute has averaged 3,500 per month. Visitors from all parts of the world were registered and illumination problems of every kind were submitted and discussed.

Shrinkage of Piles in Transit a Negligible Quantity

Investigation Indicates No Necessity for Shipping Larger Piles Than Specifications Call For Due to Subsequent Shrinking

By James W. Orton
Assistant Civil Engineer, Detroit Water Board

IN ORDER to determine just how much shrinkage occurred in fir piling shipped from the Oregon district to Detroit for the Detroit Water Board, two loads were accurately measured at both shipping and unloading points. The principal purpose of this investigation was to decide whether piles should be shipped larger than the requirement at point of delivery to allow for cross-country shrinkage and, if so, how much. Two carloads were measured, tip and butt, the butt measurement being actually 2 ft. from the butt and the place of measurement being marked with kiel.

The first load was shipped from Bear Creek, Ore., on July 17, 1929. Routing was via Southern Pacific, Union Pacific, Rock Island and Wabash. Weather reports were obtained from territory through which these roads traveled at the time the piles were passing through, and in every case the temperature was above normal and rainfall less than normal, an unusually dry period for shipping.

The 58 piles were in various stages of seasoning and were divided into three groups as follows: Eleven seasoned, fifteen partly seasoned and thirty-two unseasoned.

The piles were again measured as soon as delivered in Detroit on Aug. 3, seventeen days later. The measurements may be summarized as follows:

	11		15		32	
Number of piles						
Condition of piles, July 17	Seasoned		Partly Seasoned		Unseasoned	
	Tip	Butt	Tip	Butt	Tip	Butt
Average circumference in inches on July 17, in Oregon	22 11/16	40 11/16	20 1/16	40 11/16	20 1/16	40 11/16
Average circumference in inches on Aug. 3, in Detroit	22 1/16	40 1/16	19 11/16	39 11/16	20 1/16	40 1/16
Average shrinkage in circumference in inches between Oregon and Detroit	1/16	1/16*	1/16	1/16	1/16	1/16
Number of piles showing decrease in circumference between July 17 and Aug. 3: 1 in.			1			
3/4 in.					1	1
5/8 in.					1	
1/2 in.	1		2		2	1
7/16 in.		1		1		
3/8 in.	3		3	1	4	3
5/16 in.	3	2	6	2	7	6
0 in.	4	3	2	7	9	16
Number of piles showing increase in circumference same period: 1/16 in.	..	2	1	3	5	4
1/8 in.	..	3	..	1	2	..
3/16 in.	..	..	..	..	..	1

*Increase.
Note: One unseasoned tip omitted (1 1/16 in. difference) from this record.

As a matter of interest these same piles were again measured on Aug. 5 in Detroit, having lain on the ground two days. The weather throughout was warm and fair. A summary of the shrinkage between Aug. 3 and 5 is as follows:

	11		15		32	
	Seasoned		Partly Seasoned		Unseasoned	
	Tip	Butt	Tip	Butt	Tip	Butt
Average shrinkage in circumference in inches	1/16	1/16	1/16	1/16	1/16	1/16

Thus it will be seen that on unseasoned piles, two days in Detroit wrought a greater circumference change than seventeen days in transit, and even the seasoned piles showed appreciable shrinkage. Great care was used in measuring, steel tapes being used.

The second car measured was not divided into seasoned or unseasoned groups, hence some of the value of the investigation is lost. There were 67 piles shipped on July 23, 1929, from Bear Creek, Ore. They arrived and were measured in Detroit on Aug. 7, the weather in the meantime continuing fair and warm. A summary of the results of these measurements is as follows:

	Tip	Butt
Average circumference in Oregon, July 23	20 1/16	40
Average circumference in Detroit, Aug. 7	20 1/16	40 1/16
Average shrinkage in 16 days	1/16	1/16*
Number of piles showing decrease in circumference in transit: 0 in.	22	20
1/16 in.	16	14
1/8 in.	7	7
3/16 in.	4	4
1/4 in.	2	
5/16 in.	11	..
3/8 in.	1	3
7/16 in.	2	2
1/2 in.	..	3
Number of piles showing increase in circumference in transit: 1/16 in.	..	1
1/8 in.	1	
3/16 in.	1	1
1/4 in.	..	1
Total	67	67

*Increase.

Since increases in circumference are accompanied by increases in diameter, it is thought that cross-country transportation of piles results in change in size of such a small amount as to be negligible. It must be borne in mind also that the shipping season during these measurements was one of the driest on record and shipping at any other time would probably show even less shrinkage—possibly during a rainy season considerable swellage.

The Peters-McDonald Lumber Company furnished the piles in Bear Creek, Ore.; the Falkenburg & Company inspectors in Oregon made measurements in the West and Water Board inspectors made measurements in Detroit. The piles are being used in the foundation of the new filtration plant at Springwells Station, Detroit.

Large Construction Program for New York

Approximately $300,000,000 worth of new construction work during 1930 is proposed in reports received by Governor Roosevelt from various sections of New York State. Of this amount $244,800,000 is reported by New York City and more than $50,000,000 by the other cities of the state. The city of Buffalo proposes construction of new buildings the total cost of which will be $11,020,000, and streets, sewers and sewage disposal plants totaling $13,393,000. Albany expects to spend a total of $8,300,000 for the new water-supply system, port development, school construction, streets and sewers. New construction work in Rochester will involve an expenditure of $10,360,000, and Syracuse reports construction projects totaling $7,825,000.

Banks Require Farm Erosion Prevention

Alarmed by the rate at which soil is being washed down the rivers to the sea, some of the federal land banks are making a condition on loans specifying the steps to be taken to prevent erosion. Northern France, with its continual drizzle, did not impress the doughboys, but it is the ideal of the government's agricultural specialists attempting to cope with the menace of erosion. Rainfall in our central valleys is abundant, but poorly distributed. Too much of it comes down at one time. All banks are being asked to co-operate in the effort to keep the soil in its place.

1,316-Ft. C. & O. Ry. Tunnel Eliminated Under Traffic by Deep Open Cut

Heavy Temporary Timbering Required for Bracing Long Double-Track Bore at Ona, W. Va., as Overlying Rock Is Blasted and Removed

AS A PART of an extensive main-line improvement program the Chesapeake & Ohio Railway Co. has eliminated the double-track Ona tunnel, 1,316 ft. in length, 9 miles east of Huntington, W. Va., by making an open cut 2,000 ft. long and 115 ft. in maximum depth, which required the removal of more than 680,000 cu.yd. of material, most of which was classed as rock.

The Ona tunnel, built in 1907, lacked sufficient clearance for the larger rolling stock used to handle present-day traffic. The volume of the traffic on this line also has increased greatly since the tunnel was built. Moreover, the prospects are for much greater growth in the near future. There had been some spalling of the concrete lining of the tunnel, though this spalling had never reached serious proportions. In view of all of the conditions, however, the decision was made to eliminate the tunnel by an open cut.

Careful comparisons were first made of the cost of enlarging the tunnel under traffic and of eliminating it by means of a cut. These studies showed that the estimated cost of enlargement was little less than the expense involved in making an open cut. Enlarging also would have hindered traffic much more, and the hazards would have been greater. The open cut will render future operation much more economical and satisfactory, and with a bottom width of 70 ft. provides ample space for all trackage that is likely ever to be needed at this point in the system.

Plans called for the toe of one slope of the cut to be 46 ft. from the center line of the tunnel, while the toe of the other slope was 24 ft. from that line. This plan was adopted to permit the excavation to be carried to grade on one side of the tunnel so that a gantlet detour track could be used while the tunnel lining was being demolished. In the meantime, while the excavation was under way, traffic was handled through the tunnel until the detour tracks could be laid in the cut.

FIG. 2—REMOVING THE FIRST OF BOTTOM LIFT OF THE CUT
Gantleted detour tracks were later put through this part of cut while tunnel lining was being demolished.

FIG. 1—EARLY STAGE IN ELIMINATING ONA TUNNEL ON C. & O. RY. WITH DEEP OPEN CUT

Practically all of the material in the cut had to be loosened by blasting before it could be removed. In fact, much of it was tough, solid ledge rock. In order to protect traffic in the tunnel against possible damage from falls of the concrete lining, the entire tunnel was heavily timbered before blasting operations were started.

Since the timbering reduced the tunnel section so that double-track operation was impossible through it, the two main-line tracks were gantleted on the center line of the tunnel. Steps were then taken to facilitate train movements, with no blasting being done while traffic was near. To this end, a signalman, stationed on top of the hill pierced by

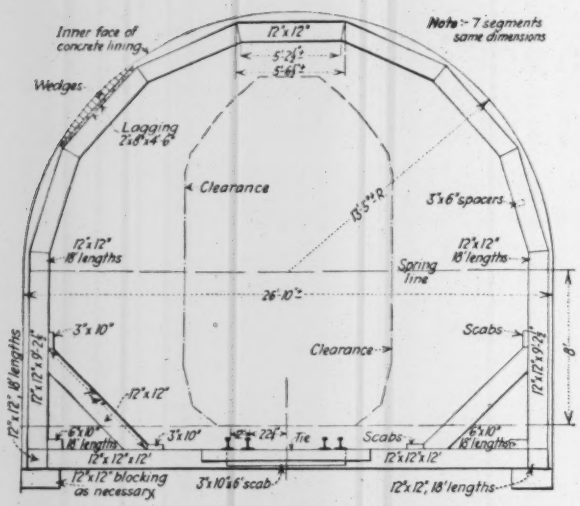


FIG. 3—DETAIL OF TEMPORARY TIMBER LINING USED TO PROTECT TUNNEL DURING REMOVAL OF OVERLYING ROCK

the tunnel, had telephone connections with the signal tower men beyond both ends of the project. He also was in touch at all times with the superintendent in charge of operations in the cut.

With this scheme it was possible to carry on the work with a minimum of interference with traffic. At the same time all hazards to traffic were avoided, not a single piece of rolling stock being damaged during the entire job.

Temporary Timber Lining—The bents of the timber lining were set 3 ft. on centers, except for a distance of about 400 ft. near the west end of the tunnel, in which length they were placed 2 ft. on centers. A 12x12-in. sill was first placed lengthwise at the foot of both the concrete tunnel lining walls. These sills were braced apart by 12x12-in. struts set 6 ft. on centers and placed with their tops flush with the tops of the track ties. Vertical 12x12-in. posts were then set on the sills at each bent of the lining. These posts were cut to the height of the springing line of the concrete lining arch. Fig. 3 shows details of the timbering.

Each third post was kneebraced against the corresponding bottom strut of the bent by a 12x12-in. timber. The beveled ends of these braces were set against short 3x10-in. blocks spiked to the struts and posts, no dapping being done in the latter. The results were satisfactory and at considerably less cost than dapping. On top of the posts was placed a 12x12-in. wall plate to carry the seven-segment 12x12-in. arch ring of the timbering. Above the wall plates the entire arch was lagged with 2x8-in. planks set lengthwise and driven tightly together.

The timber lining was placed under traffic by regular crews of the bridge and building department of the railroad. Timbers were framed and cut accurately to shape and size outside the tunnel. Sills, cross-struts, posts and wall plates were set with comparative ease, the struts being cut in half to facilitate placing and spliced with scabs as they were set.

For setting the segments of the timber arch ring two narrow movable scaffolds were used, one on either side of the track. The width of these was such that they could be placed just inside the plumb posts and still allow clearance for trains. As the timbering progressed they were skidded ahead on 3-in. plank supports laid on the cross-struts. A working platform for placing the top segments of the timber arch rings was formed by placing seven 3x10-in. planks loose across the track on the tops of the scaffolds. These planks were moved to permit trains to pass by being bunched and picked up by a block and tackle attached to one of the upper segments, and then swung aside to the top of one of the scaffolds. Lagging, placed as the timbering progressed, was cut in lengths to reach over two rings.

The first day the crews set ten rings of timbering, but they soon acquired experience that enabled them to attain a rate of 40 rings in eight hours. This was in the face of 20 to 30 train movements per eight-hour shift through the tunnel, many of which were long slow-moving coal drags of from 100 to 115 cars each.

While the removal of the material in the cut had to be handled with exceeding care, it was a comparatively

FIG. 4—AN UNUSUAL VIEW OF A TUNNEL, SHOWING CONCRETE AND TIMBER LINING STRIPPED OF COVER

simple operation. Four 1¼-yd. gasoline shovels were installed to excavate and load the spoil. At first the material was hauled from the shovels to waste banks in motor trucks. Later narrow-gage tracks were installed for operating 6-yd. dump cars in four-car trains to serve two of the shovels.

The main part of the cut was taken out in lifts of from 12 to 14 ft. in depth. Service tracks were run in both directions on ascending grades to waste banks outside the right-of-way. Gasoline locomotives handled the four-car trains of loaded 6-yd. cars on grades up to 4 per cent satisfactorily. To avoid grades in excess of that rate the tracks were shifted to lower levels whenever necessary.

While two of the shovels worked on the main body of the cut, the other two worked on the approach-cut widening at both ends. Spoil from these two end shovels was removed in motor trucks. By the time the approach

FIG. 5—SHOVEL LOADING DEMOLISHED TUNNEL LINING
Gantleted detour tracks shown at right side of cut.

cuts had been brought down to grade for the full 70-ft. width of the bottom of the completed work, the other two shovels had carried the cut as deeply as was safe on the narrow side of the cut with respect to the tunnel. A narrow-gage track was then run through on the wider side of the cut, and the remaining material was removed in two lifts down to the final grade.

Following this procedure, the cut was brought to grade with practically no disturbance of the tunnel until the last lift of material along the tunnel next to the wider side was being blasted. A shot there caused numerous cracks in the arch part of the tunnel lining, but did not cause any falls from the tunnel roof until after traffic had been diverted over a temporary gantleted track through the wider side of the cut.

Blast holes were put down with sinker drills served by portable compressors located on the berm of the cut at one side. From the start of the job exceptional care was taken to avoid injuring the tunnel lining or timbering. As the excavation came down close to the tunnel, each hole had to be placed exactly right and every load made with nice judgment of how it would fire.

The shovels also had to be handled with extreme care to avoid damaging the concrete tunnel lining. Working in this careful manner, it was possible practically to strip the cover from the tunnel lining down to the springing line of the arch. The concrete portal at each end, and about 12 ft. of the concrete lining arch at one end and 18 ft. at the other end, were removed to eliminate any chance of a cave-in. Otherwise the lining and timbering were left in place and the cut was carried down to grade in the manner described. When the detour tracks had been laid in the wide side of the cut the tunnel lining and timbering and the rest of the excavation were removed with main-line traffic on the new temporary track.

The project was under the direction of C. W. Johns, chief engineer of the Chesapeake & Ohio Railway, with H. L. Vandament as district engineer in charge and J. H. Staley as resident engineer. M. I. Dunn, Jr., is engineer of the Huntington division and R. L. Wellman supervisor of bridges. The Langhorne & Langhorne Co., of Huntington, W. Va., was the contractor on the project, with A. M. McLeod in charge as superintendent.

Tests of the Arlington Memorial Bridge

Tests are being made by the Arlington Memorial Bridge Commission and the U. S. Bureau of Standards on one of the arch spans of the Arlington memorial bridge across the Potomac River at Washington, D. C., for the purpose of obtaining data on the structural behavior of the arch during and after its construction. Arch No. 7, the one selected for testing, is the second arch to the west of the bascule drawspan and is one of eight similar concrete barrel arches which, with the drawspan, constitute the main portion of the bridge structure. Arch No. 7 was designed as a symmetrical, fixed end reinforced-concrete arch having a clear span of 177 ft. 4 in., a rise of 27 ft. 9 in. and a barrel width of 94 ft. between the outside of granite voussoir block facings. Instruments used in the tests include copper-constantan thermocouples and resistance thermometers for measuring the concrete temperature at various points. The thermocouples are connected to a multiple point potentiometer recorder. Rotations and deflections of the back of the arch barrel are measured by means of clinometers on a continuous line of clinometer stations extending over the extrados and a portion of each supporting pier. Readings are also made on several lines of clinometer stations situated transversely on the extrados. The strains in the extrados of the arch are measured by means of strain gages on ten groups of strain-gage stations. The concrete strains near the intrados are measured by means of electric telemeters, one of which is located radially beneath each group of strain-gage stations. The extrados bending strain was measured separately at selected points by both the clinometer and the strain gage and telemeter.

Under the assumption of no relative change in pier elevation between the tests, it was found possible to measure the crown deflection with a probable error of two-thirds of 1 per cent. The clinometer accuracy was found to be sufficient to obtain significant deflection measurements corresponding to a uniform temperature change as low as two-thirds of one degree Fahrenheit. The temperature of the concrete in the thicker portions of the arch barrel reached a maximum of 140 deg. F. within a period of 24 to 36 hours after being placed.

Engineering Costs on Railroad Construction

Studies Made in Determining the Cost of the Railroads of This Country Under the Valuation Act of 1913 Have Been Summarized to Reach a Basic Factor—Post-War Conditions Have Had Little Effect on the Total Percentage

By H. E. Hale

Vice-Chairman, Eastern Group, Presidents' Conference Committee, New York, N. Y.

ENGINEERING costs on railroad construction have been difficult to obtain accurately. This is largely due, first, to this cost usually being expressed in per cent where both the cost and the base fluctuate, and second, that there have been so few data available that it was difficult to determine the laws which governed the variation in cost of engineering. The railroad valuation law of 1913 required among other things that the "cost of reproduction new" should be determined for each railroad. This necessitated collection of accurate data showing the cost of engineering which is covered by "Account No. 1 Engineering" in the railroad

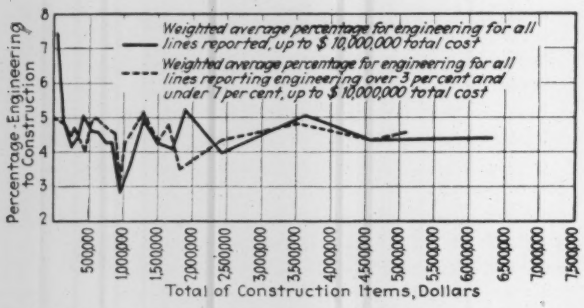


FIG. 1—COST OF ENGINEERING GROUPED ACCORDING TO TOTAL COSTS

classification of accounts kept for the information of the Interstate Commerce Commission.

Following the enactment of this law in 1913, there was assembled and analyzed, by four independent committees of the Railway Presidents' Conference Committee, a vast amount of data showing the engineering costs of railroad construction. These studies have been carried on continuously down to the present date. On account of the great volume of data studied and the care with which it was analyzed, the conclusions drawn from those studies are presented herewith in the hope that they will be useful to construction engineers and others in preparing estimates for cost of engineering on new work.

Engineering in the United States—The engineering profession is supposed by many men to be a very old profession, and in some ways it is. For example, we have engineering works like the Great Pyramids in Egypt, the Great Wall of China, the system of irrigation built by the Incas in Peru, the aqueducts and water system of Rome, etc. All these engineering works were built many centuries ago and required great engineering skill. However, the engineering profession as it exists today in the United States started with the construction of the Erie Canal in 1815, the first large engineering work built in this country.

In a most interesting book on the history of 4,400 miles of canals built and abandoned in the United States, entitled "Old Towpaths," by Alvin F. Harlow, we read: "When the first canals were built (1815) there was not a native-born engineer in America and almost none of any nationality." Again we read: "The running of lines and levels was well understood at that time, but the mechanical department of engineering was practically in its infancy." Ashbel Walsh, president of the American Society of Civil Engineers in 1882, said: "Many of the distinctive characteristics of American engineering originated with those Erie Canal engineers. We practice their methods today. . . . As a class they wrote little; there were then no engineering papers prepared and no engineering societies to perpetuate them if they had been prepared. Few men ever accomplished so much with so little means."

In building the canals of the United States new engineering works were devised, such as the double flight of locks at Lockport and the hydrostatic weighing locks at Troy, Utica and Syracuse. In constructing the Champlain Canal Mr. Geddis built it with many curves "to avoid accumulation of water and its waves by which its banks would be washed." The Morris Canal was constructed with 23 inclined planes that were operated by means of waterwheels. On the Delaware & Hudson Canal a suspension aqueduct 600 ft. long was built in 1846, which was the first of its kind in existence. The cables of this aqueduct rested in iron saddles on ston

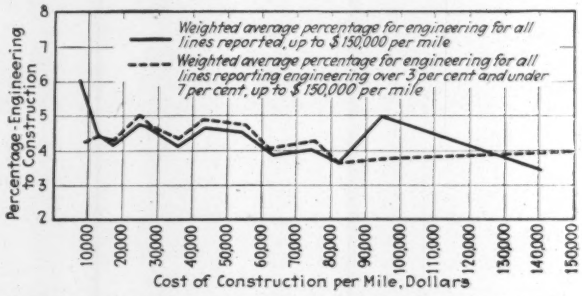


FIG. 2—COST OF ENGINEERING GROUPED ACCORDING TO COST PER MILE

towers, and this bridge is still in use today as a highway bridge across the Delaware River.

We have many definitions of engineering and engineers. Two rough and ready definitions of an engineer are, one, "An engineer is an educated pack mule," and another, "An engineer is a man who can do for the least money what any one can do with unlimited money." As usual, the correct definition probably lies somewhere between these two extremes. Engineering on railroad construction consists of planning, surveying, designing and supervising the construction of the project.

Cost of Engineering Required by the Valuation Act—From a review of a great number of projects the committees of the Railway Presidents' Conference Committee assembled the records showing cost of engineering.

These records indicated that the cost of engineering varied from less than 2 per cent to more than 10 per cent, a wide variation which Charles Hansel, of the Presidents' Committee, accounted for in the statement that "the lower percentages were for quantitative engineering such as the great fills and bridges on the Lackawanna Railroad cutoff in New Jersey and the larger percentages were for qualitative engineering such as the subaqueous Hudson River tunnels at New York." This distinction probably does explain a large part of the difference in cost of engineering on individual projects in railroad construction, but further analysis was considered necessary and a vast amount of data was accordingly collected, tabulated, analyzed and reported in condensed form for use of carriers in their valuation work and engineering estimates for new projects.

As a rule, in railroad construction it was found that what might be termed quantitative or qualitative engineering did not extend over long stretches of road but was confined within rather narrow limits. It was therefore decided to report the average of all engineering and depend upon the engineer using the data to make adjustments for quantitative or qualitative engineering in what

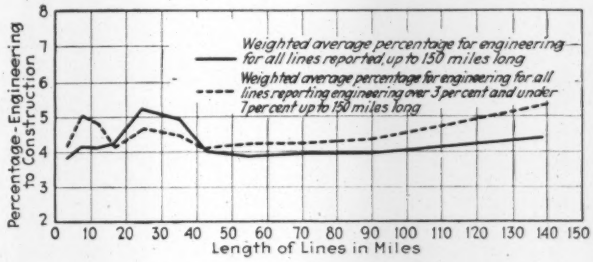

Percentage-Engineering to Construction
Weighted average percentage for engineering for all lines reported, up to 150 miles long
Weighted average percentage for engineering for all lines reporting engineering over 3 per cent and under 7 per cent up to 150 miles long
Length of Lines in Miles

FIG. 3—COST OF ENGINEERING GROUPED ACCORDING TO LENGTH OF LINE

might be termed projects within rather narrow limits or special cases.

Unit of Cost of Engineering—The various committees discussed the possibility of using some other cost unit than a percentage of the whole for determining cost of engineering on a project. For example, for steel bridges, locomotives and cars, the most generally used cost unit was the pound; for grading and masonry, the cubic yard; for buildings, the cubic foot, but no similar cost unit for engineering was devised.

This effort to develop a cost unit for engineering other than percentage was caused by the objection, sometimes made, to expressing cost of one item as a percentage of another. To overcome this objection, one committee proposed to determine the cost of engineering by the synthetic process—that is, building up the total cost of engineering by estimating the cost of each part; that is, salaries of chief engineer, resident engineer, assistant engineer, clerks, traveling expenses, equipment, etc. While this method was found fairly reliable for small projects, it was found to be inaccurate for large ones and was considered too much dependent on the judgment or personal inclination of the individual making the estimate. Because the synthetic method of determining cost of engineering was considered much less accurate than by determining this cost as a percentage of the whole cost, no further efforts were made to determine detailed engineering costs. In addition, if cost of engineering is expressed in per cent, the committees found it had the very distinct advantage of simplicity as compared with the complicated data necessary to build up a synthetic estimate.

Analysis of Cost of Engineering—The principal analysis of cost of engineering made by the committees consisted chiefly in grouping the data under various headings such as "total cost of project," "cost per mile of line" and "cost of engineering per length of line"—that is, an effort was made to see whether engineering cost relatively more on large projects than on small ones, etc. Figs. 1, 2 and 3 show an analysis of this sort done under the direction of George H. Burgess, one of the committee chairmen, covering a study of more than 8,000 miles of railroad construction, costing more than $320,000,000.

During similar analyses of other data showing cost of engineering the writer became convinced that the percentage of cost of engineering decreased as the total cost of the railroad per mile increased. For this purpose, diagrams were developed which were like the proverbial "coat of many colors." These diagrams brought out much discussion and finally culminated in the conclusion that even with all our data (24,000 miles) we could not swear that the relative cost of engineering decreased as the cost per mile increased and defend this conclusion on the witness stand.

While the analyses in regard to the effect on the relative cost of engineering which was caused by "cost of line" and "length of line," etc., did not develop any distinct trend, these studies nevertheless did prove that the effect of these conditions was negligible. On the other hand, the studies indicated clearly that the cost of engineering on canyon lines and terminals was relatively more than for the average railroad construction. These two kinds of railroad construction were the only groups that stood out clearly as having a different percentage

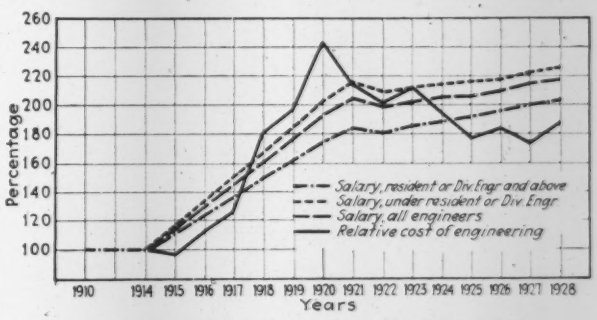


FIG. 4—RELATIVE SALARIES OF ENGINEERS

of cost of engineering than the average. The following table clearly illustrates this point:

Kind of Line	Miles	Total Cost	Cost of Engineering	Per Cen
All	24,053	$906,498,279	$40,583,620	4.48
Canyon	997	43,309,415	2,743,296	6.33
Terminals	.....	29,172,350	1,702,341	5.83

In building canyon lines the surveying is extremely difficult and the engineers frequently have to be held in place by ropes while they work. Also, the engineering work of directing the construction is equally difficult and it is therefore easy to see why this cost is relatively greater on canyon lines than on ordinary railroad construction. In constructing terminals the surveying is much more complicated than on line of road outside of the terminals. The proper location of terminal facilities requires the highest engineering skill. The direction of the work of constructing complicated track layouts, which are different in each terminal, and the construction of the

engine house and shop, coal tipple, cinder pit, etc., require very careful direction.

Result of Analysis—When the analyses of cost of engineering were started some of the engineers of railroads in the United States stated that the complete cost of engineering of a railroad was more than 6 per cent for the whole road. However, the final studies indicated that it was more nearly 5 per cent of the fixed physical property exclusive of land.

Four Independent Studies—There were in all four independent studies of cost of engineering made for four separate committees, and while many of the projects found their way into more than one study, yet each committee worked absolutely independently of the other committees and arrived at their conclusions based on the facts tabulated and analyzed by them. The first committee, with George H. Burgess chairman, collected and analyzed data at Albany, N. Y., the second, Charles Hansel chairman, at New York City, the third, W. H. Hulsizer chairman, at Omaha, Neb., and the fourth, D. W. Smith chairman, at Columbus, Ohio. A summary of the studies of all four committees is best shown by Table I.

TABLE I—SUMMARY OF RECORD COST OF ENGINEERING RAILROAD CONSTRUCTION PREVIOUS TO 1915

These percentages are based on recorded cost of engineering where it was known that all the costs were not included.

	New England Group Committee	Pittsburgh-Chicago District Committee	Western Group Committee	General Committee of P. C. C.	Projects Where Records Were Known to Be Complete
Miles	8,455	28,664	19,391	24,053	5,847
Per Cent	4.23	4.49	4.57	4.48	5.17

It is interesting to note the marked similarity of the percentages obtained by the four independent committees based on all recorded data summarized, regardless of whether the record included complete cost or not. These percentages, however, are known to be based on records that were incomplete and did not include all engineering costs. Special attention should be called to the last item, showing cost of engineering at 5.17 per cent for projects where record costs were known to be complete and therefore can be considered most reliable. The mileage of railroad built where record of cost of engineering is complete is small by comparison with all the mileage studied; nevertheless, this mileage is equal to double the distance from the Atlantic to the Pacific Ocean and this is vastly more data than most engineers have available on which to base estimated costs.

Carriers' Records—As soon as the records of the carriers' cost of engineering were investigated it was noted that there were a number of omissions in this account. These omissions consisted of such items as the chief engineer's salary and cost of office force, which was charged elsewhere. Preliminary surveys were made in some cases many years previously to the actual construction, and while the plans and reports so developed were available to the engineers starting the new construction, the costs of the early surveys were never charged to this particular project, where they rightly belonged. In addition, services of subordinate engineers in the operating department were used during construction without charging their time to the new line. To counterbalance these omissions, practically no costs were found to be incorrectly charged to engineering that should have been charged to other accounts—that is, such items as cost of grading, bridges, buildings and the like were rarely, if ever, charged to Account No. 1, engineering.

An effort was made to estimate the amount of omitted costs in each project properly chargeable to engineering, but the difficulty of finding all of the cost items actually omitted and the amount of the omission was so great that this effort was never very satisfactory to the committees.

Pre-War Costs—The great upset of prices and costs caused by the World War has raised the question whether the percentage of cost of engineering has remained the same now as it did during the comparatively lower level of construction costs previous to the war. In answer an interesting progress report has been made by D. W. Smith and his committee on Cost of Engineering, Pittsburgh-Chicago District, published on June 24, 1929. From his report the percentages given in Table II have been determined for each year, 1915 to 1927.

This report embraced the study of 1,564 miles of new railroad built during the years 1916-27. The cost of engineering ($6,420,543) for all the projects was 4.66 per cent of the total cost of construction ($137,796,814).

TABLE II—SUMMARY OF PITTSBURGH-CHICAGO DISTRICT SUBCOMMITTEE'S PROGRESS REPORT ON ENGINEERING

Dated June 24, 1929
D. W. Smith, Chairman

(1) Year	(2) Cost of Construction, Excluding Land	(3) Cost of Engineering	(4) Engineering Per Cent
1916	$2,344,675	$100,876	4.30
1917	2,702,870	111,358	4.12
1918	3,869,559	183,259	4.74
1919	3,051,227	130,425	4.27
1920	2,600,333	140,564	5.41
1921	4,293,701	219,322	5.11
1922	7,569,970	401,145	5.29
1923	16,281,144	849,798	5.22
1924	21,494,900	986,673	4.59
1925	23,081,953	987,098	4.28
1926	27,553,837	1,268,363	4.60
1927	18,652,842	821,231	4.40
1928	3,349,132	167,218	4.98

The similarity of this percentage to pre-war percentages is very marked. Both were taken from the records which were known to omit certain costs as indicated by the following paragraph in the report.

> In many instances the costs of general supervision, which was furnished by the chief engineer and his office staff, and the advantage of having the carrier's standard plans already prepared and available are not included in the engineering costs as set up in this study, such costs being considered incidental and charged to operating expenses of the carrier having the work of construction in charge.

In Mr. Smith's analysis of the cost of engineering he developed the diagram given in Fig. 4 showing change in salaries of engineers, and on this same diagram has been shown the relative cost of engineering based on the percentages taken from Table II.

As the cost of engineering is made up almost entirely of salaries and wages, it might be assumed that the change in salaries of engineers would give a good index of the change in the total cost of engineering. However, other conditions upset this assumption, as can be seen in Fig. 4. For example, calculating machines and similar devices have reduced the time necessary for engineering work in the office; improved field instruments and the motor car have lessened the work in the field. To counterbalance these savings many engineers and their assistants are now paid overtime, which was not the general practice before the war. In the good old days a field engineer and his assistants were expected to work in the field all day and in the evening work up their notes and reports for forwarding to the central office without being paid overtime.

By presenting the cost of engineering in this paper both as a percentage and as a relative cost before and after the World War it is hoped that these data may be of value to construction engineers and others.

Pere Marquette Railway Extends Its Concrete Roadbed

Cellular Instead of Solid Block Design Used in New York—Reinforcement and Rail Fastenings Simplified

By Paul Chipman
Chief Engineer, Pere Marquette Railway, Detroit, Mich.

A notable though small experiment with a radically new type of track construction was started by the Pere Marquette Railway in 1926, with about ¼ mile of concrete roadbed to which the rails were anchored. Experience has warranted an extension of this roadbed, but a simplified design intended to reduce the cost has been adopted, as described in the following article. —Editor.

FAVORABLE results with a concrete roadbed built in 1926 on the Pere Marquette Railway have led to a simpler and more economical design, which was built in September, 1929, for a length of 390 ft. adjoining the 1,326 ft. of the earlier construction. Figs. 1 and 2 show the track completed and under construction, while Fig. 3 shows the new design of roadbed.

The first section, installed in the main track at Beech, 12 miles from Detroit, was placed in service on Dec. 19, 1926, and after nearly three years it shows no sign of deterioration. There has been a slight and remarkably uniform settlement, but practically all of this occurred in the first few days of operation. The purpose was to determine whether a rigid track support was practicable and to get some idea of the difficulties encountered in construction and maintenance and thus obtain a basis

FIG. 1—CONCRETE ROADBED ON PERE MARQUETTE RAILWAY
Solid block construction in foreground. Beyond is new design with monolithic stringers and base slab.

for improvement. Since little was known of the requirements of such a track support, the principal consideration was to make it amply strong, without paying much attention to economy of design. Definite information as to cost was not expected from this short experimental section, but on the basis of highway construction the original design would cost probably about $60,000 per mile of single track.

The original construction consists of solid concrete about 9 ft. wide and 21 in. deep, with a structural steel truss under each rail, as well as rod reinforcement (see *Engineering News-Record*, Feb. 24, 1927, p. 317, and Jan. 26, 1928, p. 151). One rail rests directly on the concrete, while the other is separated from it by a ⅛-in. layer of pressed wood fiber which was installed for insulation but has other advantages. There has been practically no creeping of the rail where the fiber was used, but the other rail has shown a tendency to creep in the direction of traffic. With a thin layer of comparatively soft material between the rail and concrete, the fastenings will maintain a firmer grip than if the rail rests directly on the concrete.

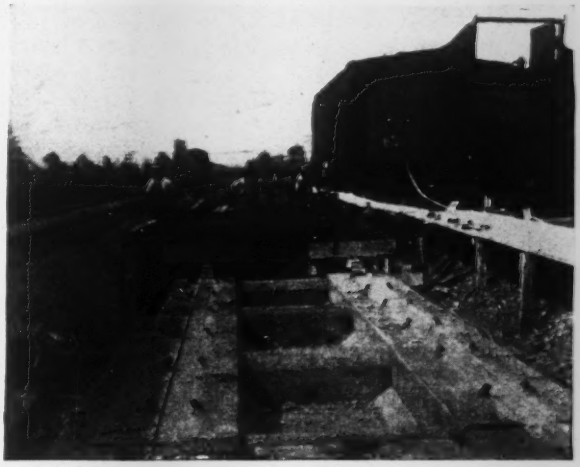


FIG. 2—BUILDING CELLULAR CONCRETE ROADBED

The new design (Fig. 3) contains practically the same amount of reinforcing steel per foot of track as the old one, but it eliminates structural steel, only ordinary reinforcing bars being used. Assuming a stress of 16,000 lb. in the steel with the old design, the compressive stress on the concrete is only about 350 lb. per sq.in. The new design requires ⅜ cu.yd. of concrete per linear foot, which is 40 per cent less than the old design, and the compression amounts to between 600 and 700 lb., giving a liberal factor of safety. In both installations great care was taken to produce concrete of high quality. The water-cement ratio was used in proportioning, with about 4½ gal. of water per bag of cement and eight bags per cubic yard of concrete.

This new roadbed may be described as a platform 6 in. thick and 9 ft. wide, on which are two girders which support the rails. These girders, 2 ft. wide and 14 in. high above the platform, are connected by heavily reinforced crosswalls at intervals of about 6 ft. In the first installation the sections are 39 ft. long. In the new installation they are 19 ft. 6 in. long, or half the length of a rail. Tongue-and-groove horizontal expansion joints between the sections prevent independent vertical motion of the roadbed.

Each rail rests on a ⅞-in. creosoted yellow pine board which is slightly narrower than the base of the rail and is in a shallow depression in the girder. The rail is held in place by means of anchors set in the concrete at intervals of 39 in., as shown in Figs. 3 and 4. A bolt through the anchor bears on a cast-steel clip on the edge of the rail base. A small amount of both lateral and vertical adjustment is thus provided and is necessary on account of the impossibility of setting anchors in concrete in a perfectly straight line. The board under the rail affords the desired flexibility of grip for the fastenings and

also avoids the rigidity that is felt in riding over a rail which rests directly on concrete.

In certain locations where settlement would necessitate occasional lifting of the slabs to remove slight inequalities of surface, this can be done quickly and economically on a large scale by lifting with jacks and forcing sand under the slab by means of compressed air. Experiments made with a wooden platform instead of the slabs show that this method is entirely feasible. For lifting, two heavy stirrups are set in the concrete near one end of each slab. An outfit consisting of a motor car carrying a compressor, a cement gun and a supply of sand could resurface several hundred feet per day. The space between the girders is filled with gravel, and an earth and gravel shoulder is built up outside (see Fig. 1) in order to lessen the danger in case of derailment, to afford better protection from frost and to do away with the noise of grinding wheels and rattling equipment which occurs when the track support is wide, smooth surface.

The estimated cost of the new design is about $40,000 per mile, but 90-lb. rail and fastenings would bring the total to $48,000. Although the new section was put into service Sept. 20, it has proved to be an improvement in a number of ways. Levels taken a short time after operation began show a settlement which varied from $\frac{1}{16}$ to $\frac{3}{16}$ in. These levels were taken at the joints and the

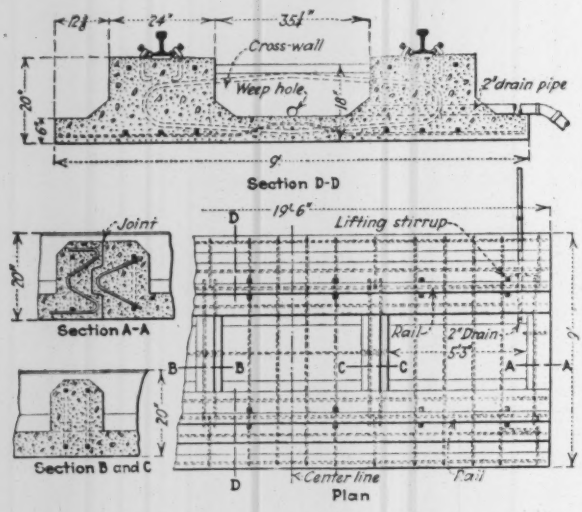


FIG. 3—NEW CONCRETE ROADBED, PERE MARQUETTE RAILWAY

settlement was remarkably uniform. The principal improvements in the new design are as follows: (1) cost reduced 35 per cent without sacrificing strength; (2) provision for a practical method of restoring surface; (3) lateral adjustment of rail; (4) elimination of insulation troubles, reflected noises and rigidity. Features in both plans have been covered by patents.

Advantages of Concrete Roadbed—For roadbed of the type described, the principal advantages are as follows: (1) greater safety; (2) higher permissible speed; (3) lower cost of maintaining track; (4) probable lower cost of maintaining equipment; (5) reduced train resistance. Reduction in track maintenance is perhaps most important and at any rate the most tangible. Renewal of ties and ballast is eliminated. Owing to its continuous support, the rail may be made lighter in section and much harder, thus greatly reducing the cost and frequency of rail renewals. Track labor is almost eliminated, being reduced to inspection, rail renewal and occasional adjustment for surface. The saving in cost of maintaining track would depend largely on the density of traffic, but study of operating statistics on a number of railroads indicates that $2,000 or more per mile would be saved under heavy traffic conditions.

Saving in maintenance of equipment cannot be measured until a considerable mileage of the improved track is in use, but the elimination of low joints and rough spots in track should result in a considerable reduction

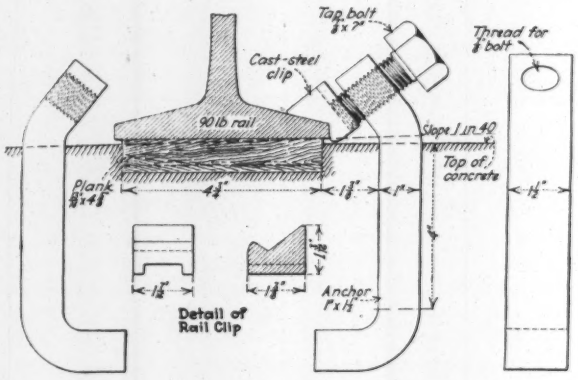


FIG. 4—DETAIL OF RAIL FASTENINGS

of this expense. Experiments with drifting cars on the first installation indicate a reduction of about 15 per cent in train resistance as compared with the adjoining track of ordinary construction. The value of a firm and massive track support is enough, when combined with the tangible saving that would result in cost of maintenance, to make more extensive experiment along this line highly desirable.

Inasmuch as the cost of first-class track of the usual type runs as high as $30,000 to $35,000 per mile, the additional cost of $15,000 to $20,000 for a track with a permanent roadbed would be amply justified in many cases.

Six-Mile Railway Tunnel in Japan

In the 6-mile Shimizu tunnel on the Japanese Government Railways the headings were holed through in December last, and at the end of 1929 the length completed was 31,213 ft., out of a total length of 31,831 ft. The tunnel, which should be ready for traffic by the fall of 1931, is single-track but will be widened at the middle for a passing track in order to increase the traffic capacity. This tunnel is on the new Joyetsu line between Takasaki and Nagaoka, 102 miles, of which 82 miles are now in operation. Work at the portal on the Takasaki end of the tunnel was begun in August, 1922, and at the opposite end in October, 1923. In general the rock was hard and compact, but it contained many seams or faults filled with soft material. Good progress was made until the end of 1926, when disintegrated and caving rock was encountered, with a fissure discharging water at the rate of 12 sec.-ft. Before work could proceed in the heading it was necessary to drive a drainage tunnel parallel with the main tunnel, the former being completed by the end of 1928. Since then the heading has been advanced steadily. The construction methods used on the Shimizu tunnel were described in *Engineering News-Record* of July 30, 1925, p. 171.

Driving the Tanna Railway Tunnel in Japan

Many Methods Employed to Combat Volcanic Rock, Faults, Clay, Swelling Ground and Water at High Pressure—Shields, Compressed Air, Cementation and Drainage Tunnels Resorted To With Headings 6,000 Ft. Apart After Eleven Years of Work

DIFFICULTIES and dangers have so hampered the work on the Tanna tunnel on the Japanese Government Railways that only about 75 per cent of the bore started in April, 1918, had been completed in June, 1929. The tunnel is 18x14 ft. and 25,614 ft. long; it provides for a double-track 3½-ft. gage railway. Because of the enormous pressures the tunnel requires a concrete lining 28 in. to 75 in. thick at the crown. In general, the side walls are poured concrete, whereas the arch is precast concrete blocks. Fig. 2 shows the condition of the work in July, 1929.

The tunnel and construction methods were described in *Engineering News-Record* of March 9, 1922, p. 394; April 3, 1924, p. 559, and Aug. 27, 1925, p. 336. Headings have been driven from both ends and originally it was expected to average an advance of 180 ft. per month and to complete the driving in seven years, or in 1925; in 1925 the date of completion was advanced to 1929. There remains, however, about 6,000 ft. of doubtful ground between the headings.

The following description of the methods and difficulties is summarized from a paper presented at the recent international engineering congress in Tokyo by S. Kurokochi, director of the bureau of construction, Japanese Government Railways.

Geological Conditions—The tunnel is in a volcanic formation of varying character broken by numerous faults. Above the mid-length is a great depression known as the Tanna basin, which was supposed to be an old crater, but investigations have shown it to be due to settlement of the faulted ground. Many of the faults and fault zones were filled with soft clay and loose rocks, termed fault breccia, sometimes to a thickness of 50 ft. A special trouble has been a solfataric clay formed by the decomposition of rock through the action of hot springs and steam jets or fumaroles venting through the faults and fissures. This clay, which is almost like rock when excavated, begins to swell at once, requiring heavy support; when it absorbs water, it is likely to flow suddenly like thin mud.

Water at high pressure occurs in great volume in cavities along and above the line of the tunnel, reaching a maximum flow of 123 sec.-ft. at the west side on May 8, 1925. At present the flow from each portal is about 25 sec.-ft. A pressure of 275 lb. was encountered in 1926 at the east side, where impervious faults had obstructed the flow of the underground waters. In one case the drill and drill man were thrown 15 ft. from the heading when the rod broke through into a water pocket. Rock temperatures of 82 to 138 deg. F. were predicted, but the maximum has been 82 deg. at 4,300 ft. from the east portal. After an inrush of water this temperature fell to 61 deg. At 900 ft. from the east portal a spring of 97 deg. F. was struck, but its flow soon stopped. With the draining of the great volumes of water, many wells and springs have failed and there has been surface settlement over the tunnel.

Tunneling Practice—In ordinary ground a bottom heading is driven, about 12 ft. wide and 9 ft. high, with a ditch or drain in the middle of the floor, which is at subgrade. At intervals a shaft is driven upward to the roof level, and top headings are started in both directions. Then the top heading is widened, and the bench is removed in two full-width lifts, down to the roof of the bottom heading. This heading is then widened on each side and is finally again widened to full section. The lining is placed as soon as the enlargement is completed. These stages are indicated in Fig. 4. In general, this practice has been followed for a total of about 16,000 ft. With unstable ground and heavy pressures, various special methods have been adopted. Timbering consists usually of unbarked pine logs about 15 in. in diameter, but steel frames and concrete blocks have been required in some parts of the headings.

When the great flow of water proved to be too vast for the capacity of the floor drain, after the west heading

FIG. 1—DRIFTS IN THE TANNA TUNNEL, JAPAN
At right—Drift for bypass in soft clay on east side, March, 1929. At left—Drift in shattered fault on west side at 4,950 ft. from portal.

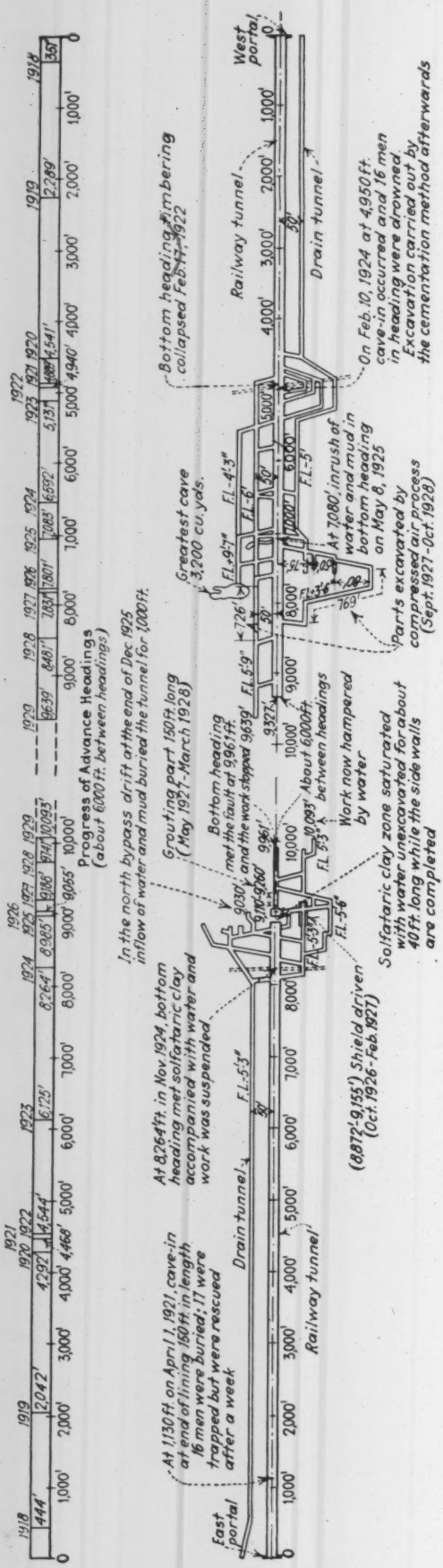

East portal
Drain tunnel
Railway tunnel
West portal
Progress of Advance Headings (about 6000 ft. between headings)
In the north bypass drift at the end of Dec. 1925 inflow of water and mud buried the tunnel for 1000 ft.
At 1,130 ft. on April 1, 1921, cave-in at end of lining 150 ft. in length. 16 men were buried; 17 were trapped but were rescued after a week
At 8,264 ft. in Nov. 1924, bottom heading met solfataric clay accompanied with water and work was suspended
Grouting part 150 ft. long (May 1924-March 1928)
Bottom heading met the fault at 9,961 ft.
Greatest cave 3,200 cu. yds.
Bottom heading timbering collapsed Feb. 12, 1922
At 7,080' inrush of water and mud in bottom heading on May 6, 1925
On Feb. 10, 1924 at 4,950 ft. cave-in occurred and 16 men in heading were drowned. Excavation carried out by the cementation method afterwards
Parts excavated by compressed air process (Sept. 1927-Oct. 1928)
Work now hampered by water
Solfataric clay zone saturated with water unexcavated for about 40 ft. long while the side walls are completed
(8,872'-9,155') Shield driven (Oct. 1926-Feb. 1927)

FIG. 2—PLAN OF TANNA TUNNEL, JAPANESE GOVERNMENT RAILWAYS

Note the extraordinary series of drifts to explore, drain or avoid bad ground. East and west main headings were about 6,000 ft. apart in July, 1929.

was at about 6,900 ft., it was decided to drive a drainage tunnel, 6x6 ft., parallel with the main tunnel but 40 ft. from it and 5 ft. below subgrade level. It has a capacity of 150 sec.-ft. A similar drain tunnel was driven on the east side. These are permanent and are as long as the main tunnel.

Tunneling a Fault—In February, 1922, the bottom heading from the west side, at 4,940 ft. from the portal, entered a faulted zone about 60 ft. long, having a great volume of water under high pressure. Work continued in spite of extreme difficulties. Heavy timbering was used. Posts of 6-in. steel pipe filled with concrete carried caps consisting of three 75-lb. rails supporting the roof poling boards of 60-lb. rails, as shown in Fig. 5. But the earth pressure bent down the roof beams and buckled the posts, reducing the size of the heading until at 4,938 ft. further progress became impossible. A top heading was then started, but was stopped at 4,917 ft. by an inrush of water and earth. A bypass drift on the south side, 60 ft. from the main center line, had to be stopped at 4,940 ft.

The ground was also explored by horizontal drill holes from the face of the bottom heading. A bypass on the north side finally got through to the tunnel line beyond the fault, and the bottom heading was then started forward through the new ground and back through the fault, this latter part of the heading being holed through in January, 1924.

While this heading in the fault was being enlarged, a great slide occurred on Feb. 10, 1924. This was accompanied by a torrent of water. The mud, amounting to some 5,000 cu.yd., blocked the heading and the bypass drifts, trapping sixteen men, who were drowned. A rescue drift finally reached the heading, which was full of water, but it was seventeen days before all the bodies were brought out. Consolidation of the bad ground by grouting was then decided upon, but as this would take considerable time a new bypass drift was driven on the north side, to reach the farther end of the bottom heading, beyond the slide, so that work could proceed at the face while another force attacked the slide.

Grouting a Fault—This cementation or grouting at 4,900 ft. was done from the abandoned top heading, as shown in Fig. 6, the headings and drifts being first sealed with concrete bulkheads 9 ft. thick to guard against slides that might be started by the grouting. To relieve water pressures which might exceed the grouting pressure, three drain holes were drilled into the far side of the fault. For grouting, thirteen holes, 56 to 78 ft., were drilled radially. This work was completed in December, 1924, but as test holes drilled in January, 1925, showed little effect upon the loose material, fifteen holes were drilled in which perforated pipes were inserted so that the grout might permeate the ground. Solutions of calcium chloride and sodium silicate were injected alternately, followed by the cement grout. This second grouting was completed in October, 1925.

Test holes then showed little water in the grouted zone, but there was still much water about 100 ft. above subgrade. It is assumed that the second grouting did not effectively seal the outflow, but that the continuous flow of water for three years had drawn down the large underground body of water, which at first had a pressure of 110 lb., so that its reduced pressure facilitated the grouting.

Concreted Drifts—Work was then resumed on the completion of this 60-ft. isolated portion of the tunnel,

FIG. 3—DANGERS IN THE TANNA TUNNEL
Above—Steel I-beam timbering buckled by swelling ground on the east side, February, 1929. Below—Torrent of water in drainage tunnel on west side, June 1, 1926.

but as the great slide of about 8,000 cu.yd. had undoubtedly left large cavities in the ground, a special method of procedure was adopted, as shown in Fig. 7. A small drift above the crown of the arch was driven 60 ft. through the faulted zone and was at once filled with concrete by the pneumatic process. Eight similar drifts were driven and concreted in succession until the tunnel area was surrounded with a mass of concrete. Finally, this inclosed area or core was excavated and then lined to the tunnel section. This was completed in October, 1926, or $4\frac{3}{4}$ years after the disastrous slide.

Tunneling Loose Volcanic Ground—On May 8, 1925, with the west side bottom heading at 7,083 ft. from the portal, there was an inrush of water which reached a flow of 123 sec.-ft., bringing in about 5,000 cu.yd. of sand and debris (see Fig. 2). Work on this heading was abandoned in order to concentrate all efforts on the drainage tunnels on both sides. About 50 days were spent in clearing out the heading. The top heading and enlargement were then resumed, but in December, 1925, at 7,000-ft. from the portal, this heading entered an unstable formation of volcanic lapilli. Work was stopped and the ground was explored by horizontal drill holes about 500 ft. long, three of which entered large caves.

In February, 1926, the top heading was again resumed and no water was found above the spot where the great flood had burst into the bottom heading. But in April, at 7,477 ft., water and sand began to flow, and work was stopped for fear of a collapse. In June the south drain tunnel reached 7,080 ft. and diverted water from the old bottom heading. It was considered evident that the softer part of the volcanic lapilli would yield against water pressure but that such ground could be excavated safely after it had dried or drained. For this reason several drifts were driven in order to lower the water table and drain the ground. Inrushes of earth and water were frequent, but the workmen always escaped. Some of these drifts had later to be filled with concrete.

In June, 1927, with the bottom heading at 7,800 ft., dozens of cavities were found, the largest having a volume of about 3,200 cu.yd. Through the water-bearing ground lagging had to be used, which caused difficulties, and even a small drift, 7x7 ft., had to be excavated in two or four stages, using evergreen boughs to exclude the soil. To divert the water from the top heading, the north drain was advanced, until the high pressure made it unsafe to proceed. A bore-hole with $5\frac{1}{2}$-in. casing driven from the face tapped a big flow and drained all the water that had been flowing into the top heading of the tunnel.

Excavation Under Compressed Air—It was then decided to proceed with excavation under air pressure, and air locks were installed as shown in Fig. 8. On account of the numerous cavities, causing danger of sudden es-

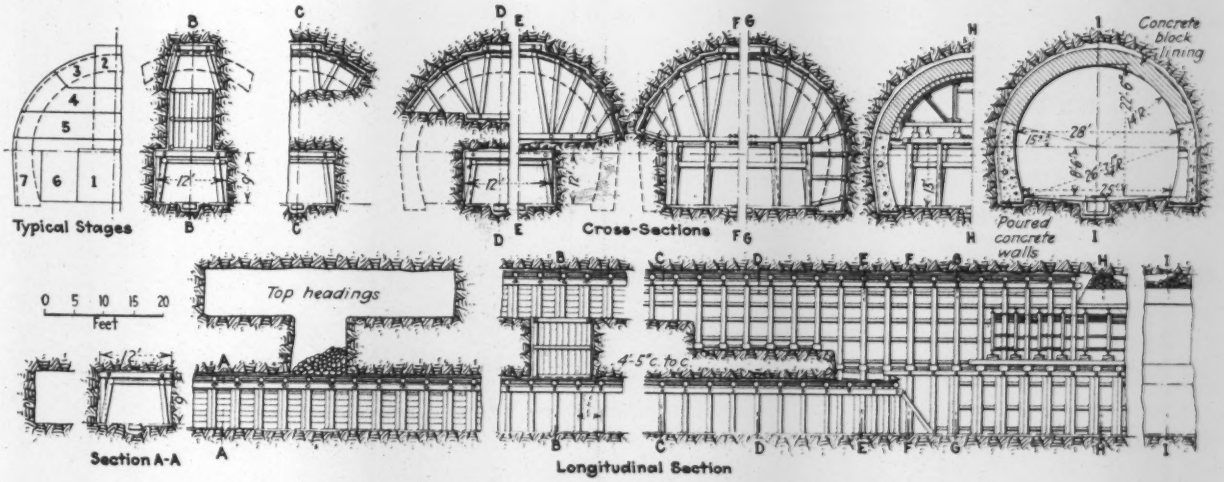


FIG. 4—TUNNELING METHOD IN FAVORABLE GROUND

cape of air and release of pressure, the north drain was carried around the zone of cavities and the south drain was started directly from the main tunnel. In September, 1927, the north drain was started and in 245 working days was advanced 769 ft. from the bulkhead. Pressure was then released, permitting water to enter. The south drain, started in July, 1928, was advanced 726 ft. in 255 working days. Its air pressure was then released, and water was allowed to drain into it. As both these tunnels had reached good ground, further work under compressed air was unnecessary.

Four compressors were provided, having a total capacity of 3,950 cu.ft. of free air per minute at 50-lb. pressure. But the leakage of air in the volcanic lapilli was so great as to necessitate increasing the capacity to 7,760 cu.ft. With 20-lb. pressure in 4 ft. of unlined heading, the leakage exceeded the capacity of the compressors. As coating the sheeting with grout and grout mixed with paint proved unsuccessful, a 9-in. concrete lining was placed inside the timbering at every 4-ft. advance, while grout was forced in as backfill above the roof when necessary. A grout coating on the face, applied by a cement gun, was used frequently to prevent leakage of air.

In the concrete lining of the south drain tunnel, Fig. 8, steel 4-in. pipe drains were inserted. Each pipe had a hinged cover with rubber packing so as to be air-tight against internal air pressure, but allowing water to pass into the tunnel when this pressure was released. The lower end of the pipe was covered with wire netting.

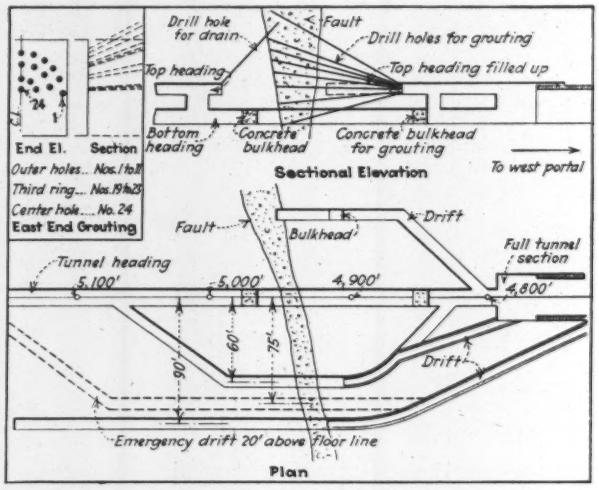


FIG. 6—GROUTING IN THE TANNA TUNNEL
Drawing shows work at west end. Small insert shows arrangement of grout holes at east end.

With the ground thus drained, the tunnel was excavated easily through this 1,500 ft. of volcanic lapilli.

Tunneling in Soft Clay—On the east side, when the bottom heading reached 8,264 ft. from the portal, in November, 1924, the favorable ground changed suddenly to the water-bearing soft solfataric clay, already mentioned. Work was then stopped for fear of a collapse.

PROGRESS ON THE TANNA TUNNEL; JAPANESE GOVERNMENT RAILWAYS

	East End				West End				Total			
	Heading		Lining		Heading		Lining		Heading		Lining	
Year	Advance	Total	Advance	Total	Advance	Total	Advance	Total	Advance	Total	Advance	Total
1918	444	444	21	21	351	351	0	0	795	795	21	21
1919	1,598	2,042	266	287	1,938	2,289	200	200	3,536	4,331	466	487
1920	2,250	4,292	596	883	2,252	4,541	1,366	1,566	4,502	8,833	1,962	2,449
1921	176	4,468	455	1,338	348	4,889	1,367	2,933	524	9,357	1,822	4,271
1922	76	4,544	1,775	3,113	51	4,940	1,504	4,437	127	9,484	3,279	7,550
1923	1,581	6,125	1,179	4,292	191	5,131	331	4,768	1,772	11,256	1,510	9,060
1924	2,139	8,264	2,260	6,552	461	6,592	0	4,768	3,600	14,856	2,260	11,320
1925	721	8,985	1,275	7,827	491	7,083	350	5,118	1,212	16,068	1,625	12,945
1926	70	9,055	627	8,454	718	7,801	1,802	6,920	788	16,856	2,429	15,374
1927	133	9,188	353	8,807	30	7,831	756	7,676	163	17,019	1,109	16,483
1928	553	9,741	205	9,012	650	8,481	164	7,840	1,203	18,222	369	16,852
1929*	352	10,093	82	9,094	1,158	9,639	515	8,355	1,510	19,732	597	17,449

*The 1929 record is up to July 31, 1929.

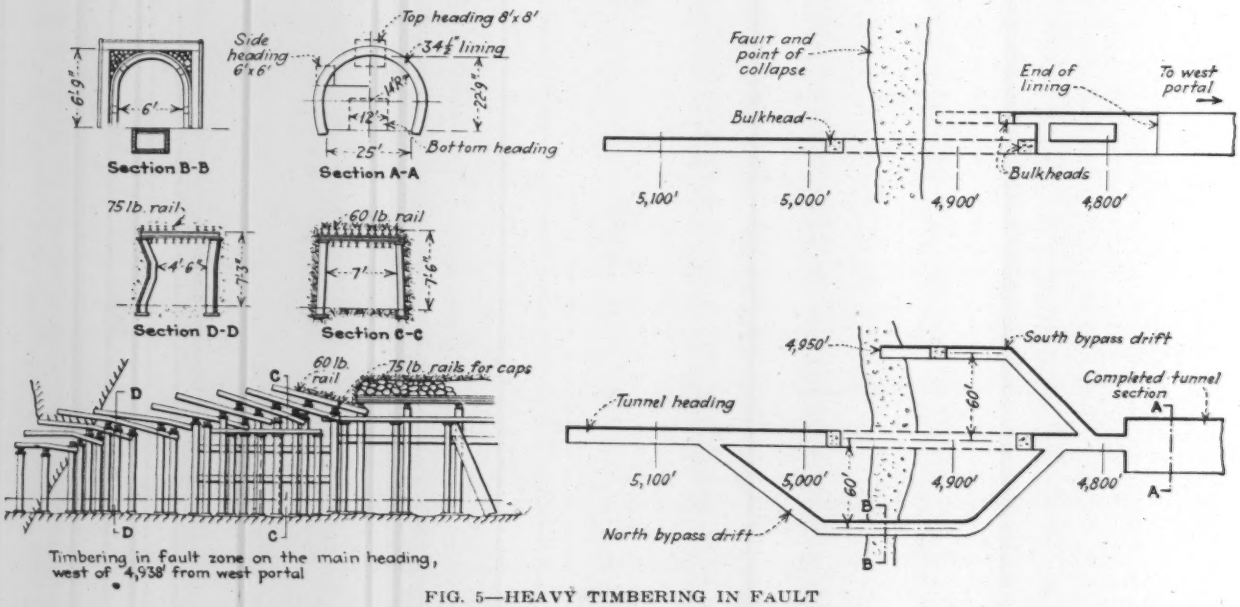


FIG. 5—HEAVY TIMBERING IN FAULT
Collapse occurred at 4,950 ft. See also Fig. 2.

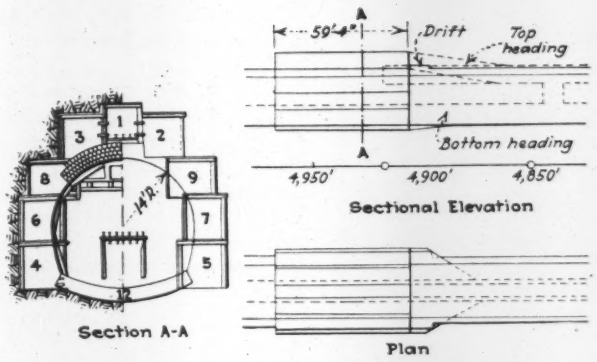


FIG. 7—TUNNELING IN SOFT CLAY
Small drifts filled with concrete surround tunnel core before excavation.

A bypass drift on the south side was abandoned, as it struck the same formation, but a similar drift on the north side avoided the bad ground and met the center line of the tunnel again at 8,394 ft. This is shown in Fig. 9. The bottom heading was then started from this point, but was stopped at 8,839 ft. in June, 1925, on account of the heavy earth pressure or squeeze and the increasing flow of water. As the timbering was crushed by the swelling ground, the heading was lined with precast concrete blocks for a length of 270 ft., as shown in Figs. 9 and 10.

An attempt to drive a bottom heading back through the bad ground from about 8,370 ft. was started in February, 1925, but had to be abandoned and this stretch of 90 ft. was left unexcavated. Bore holes to explore the ground gave no definite results, as they filled with mud, but they indicated the wide extent of the clay and the great amount of water in the faults. However, after the water had drained out two side bottom headings were started (see Fig. 9) and finally passed through the trouble zone.

A south bypass drift was started at 8,711 ft. in October, 1925, to explore and drain the ground, steel timbering being used. Work was resumed also on the main bottom heading in the clay, but this was stopped in December at 8,985 ft. on account of the heavy flow of water. The south bypass drift did not encounter the clay, and though it was in badly shattered rock, it progressed until by the end of December it had reached 9,030 ft. from the portal.

On Dec. 30 an inrush of water and mud occurred 15 ft. back from the face of the south bypass drift and was followed by others. Attempts to stop the earth by bulkheading the drift with sacks of cement proved unavailing and were abandoned on Jan. 9, 1926. The mud filled up most of the drifts and flowed through the tunnel to the east portal, whence it poured across the ground into Atami Bay. In its passage it flowed through the top heading driven in bad ground at 8,250 ft. The volume of debris was about 4,000 cu.yd. Numerous drifts were started farther back on the south side in an attempt to get around the bad ground, as indicated in Fig. 9, but all had to be abandoned, until one finally reached the center line of the tunnel at 8,800 ft. The main tunnel and north drain tunnel were cleaned out, but a test

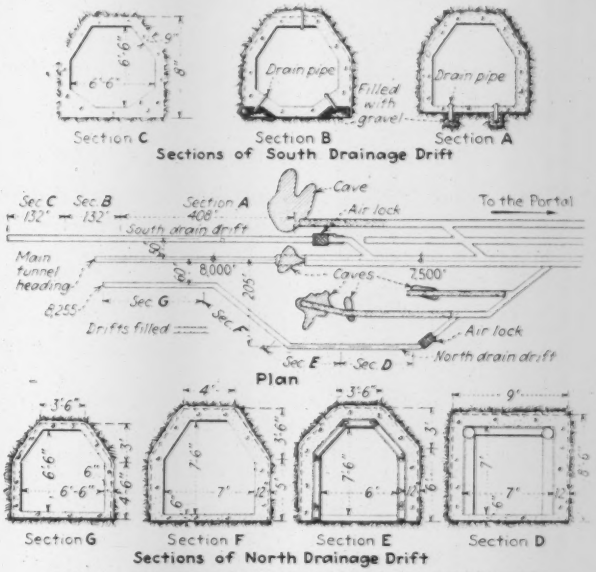


FIG. 8—COMPRESSED-AIR WORK AT WEST END

boring from the face of the latter penetrated, at about 200 ft., a body of water under 275-lb. pressure.

Shield Tunneling—It was decided to push this north drainage tunnel through the bad ground by means of compressed air and a hydraulic shield. This shield, 10 ft. long, with outside and inside diameters of 9 ft. 2 in. and 7 ft. 6 in., had eight 50-ton hydraulic jacks of 2-ft. stroke, worked at 2,000-lb. pressure. An opening in the front diaphragm could be closed with timbers in case of caving ground at the face. This air lock was completed in August, 1926, and in October the shield had reached 8,870 ft. At 9,060 ft. it became necessary to use dynamite ahead of the shield. In February, 1927, at 9,157 ft., the upper part of the face collapsed under heavy water pressure, although the lower part still required blasting. Raising the air pressure to 40 lb. was

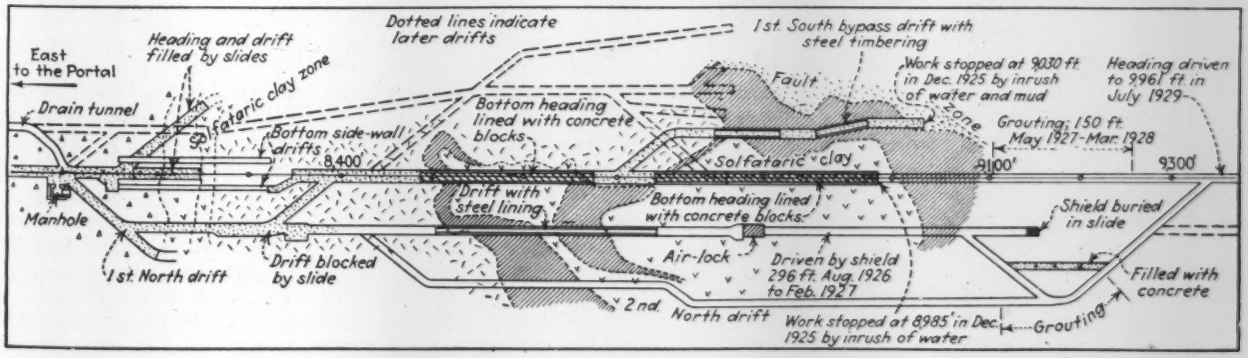

Dotted lines indicate later drifts
1st. South bypass drift with steel timbering
East to the Portal
Heading and drift filled by slides
Solfataric clay zone
Drain tunnel
Bottom side-wall drifts
8,400'
Bottom heading lined with concrete blocks
Fault
Work stopped at 9030 ft in Dec. 1925 by inrush of water and mud
Heading driven to 9961 ft in July 1929
Grouting, 150 ft. May 1927-Mar. 1928
9100'
9300'
Solfataric clay
Drift with steel lining
Bottom heading lined with concrete blocks
Shield buried in slide
Manhole
1st. North drift
Drift blocked by slide
Air-lock
Driven by shield 296 ft. Aug. 1926 to Feb. 1927
Filled with concrete
2nd. North drift
Work stopped at 8,985' in Dec. 1925 by inrush of water
Grouting

FIG. 9—HYDRAULIC SHIELD WORK AND GROUTING AT EAST END

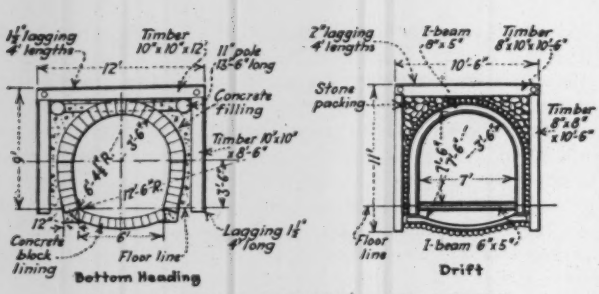


FIG. 10—LINED HEADINGS AND DRIFTS

of no avail. The shield was filled with mud and could not be pushed farther, having progressed only 296 ft.

Grouting—The next step was to reduce the inflow of water by grouting the ground ahead of the main tunnel against the 275-lb. water pressure, using pumps capable of 1,400-lb. and 2,000-lb. pressures. A mixture of 1:10 or 1:15 was discharged through 3½-in. holes 20 to 30 ft. long, arranged in four rings as shown in Fig. 6. The 20-ft. holes of the two outer rings were designed to solidify the ground about 12 ft. above the bottom heading, while the others were to seal the ground to exclude water and prevent slides at the face.

The odd-number holes were drilled first, filled with stop valves and then grouted. The even-number holes were then drilled and grouted. With the ground practically solidified for 25 ft., the heading was advanced 10 ft., leaving 15 ft. as a bulkhead. In this way the bottom heading was advanced 150 ft. (from 9,110 ft. to 9,260) during the eleven months from May, 1927, to March, 1928. As work of this kind is slow and expensive, a side drift, 6x5 ft., was driven carefully at about 27 ft. above the level of the bottom heading and in advance of it, in order to drain off water from above the face. The heading was advanced in this way, without grouting, to 9,961 ft., which was reached in July, 1929.

Completion of Tunnel—There still remains about 6,000 ft. of excavation, between the east and west headings, but how long this will take cannot be predicted, owing to lack of knowledge as to the nature of the ground, the volume and pressure of underground waters and the number, character and thickness of faults to be encountered. In July, 1929, the conditions of the construction work (see Fig. 2) were as follows: On the east side, the side wall lining had been completed through the clay slide; the roof was excavated and lining was expected to be completed in a few months. The drain tunnel and bottom heading had met another faulted zone at 10,000 ft. from the east portal. On the west side, the bottom heading and drain tunnel were progressing, each at 300 ft. per month, through stable ground, and enlargement was being done on the standard method. As a precaution, the heading of the drain tunnel is kept 120 ft. in advance of the main bottom heading, so as to detect any faults or bad ground.

Tests on Timber Poles Made in North Carolina

CHARACTERISTICS of the timber grown in the State of North Carolina, in reference to its fitness for use as poles for power and communication lines, are described in Bulletin No. 3 issued by the engineering experiment station of North Carolina State College. In "A Pole Industry for North Carolina," J. S. Holmes, state forester, points out that 54 per cent of the total poles purchased in the United States during 1925 were treated with preservative materials. The species which grow in North Carolina, however, have been treated rather infrequently, with the exception of pine, 90 per cent of which was treated during that year. Chestnut poles have heretofore furnished from 20 to 30 per cent of the total supply of the country, but, because of the chestnut blight, this source of supply will very rapidly decline and in the future will be a negligible item. The best prospect for the production of poles in the forests of North Carolina is in the pine stands, which comprise practically 50 per cent of the total forest area of the state. Loblolly pine is the most rapid growing and most widely distributed species throughout the pine region.

Taking the present pine area of the state as a whole, it seems quite possible that one-half a pole per acre per annum might be expected where forest fires are prevented. This would mean, roughly speaking, an annual yield of 5,000,000 poles, which is 50 per cent more than the total pole production of the whole United States.

William Hand Browne, Jr., and James Fontaine, in "Tests of North Carolina Poles for Electric Distribution Lines," describe the results of tests made on poles of various species grown in North Carolina. The woods tested included chestnut, five species of pine, cypress, gum and juniper. Of the 110 poles tested to destruction all were untreated with the exception of five of slash pine and 38 of longleaf pine. The poles were set up in as nearly as possible a representative condition by a regular construction gang. A force was then applied to a point near the top of the pole by a steel cable that made only a small angle with the horizontal. The average values of the modulus of rupture for the various species ranged from 9,846 lb. per sq.in. in the case of longleaf pine to 4,603 lb. per sq.in. for juniper. Poles of gum, however, gave values very close to those of longleaf pine, the average of those tested being 9,823 lb. per sq.in. An interesting feature of the test on the chestnut poles was the occurrence of the break at the axe cuts made by the men who stripped the bark off. The tests were not conclusive as to the effect of the creosote treatment on the strength of the poles, as only one wood, longleaf pine, was obtained for testing both treated and untreated.

Strength of Treated Fir Timbers

Tests made to determine the effect of creosoting on the strength of Douglas fir timbers have indicated serious reduction in strength by both the boiling and the steaming processes, but a relatively small reduction by the boiling-under-vacuum process, according to a paper by T. R. C. Wilson, senior engineer of the U. S. Forest Products Laboratory, at the University of Wisconsin. His conclusion is that for timbers up to 8x16 in. in section treated by the latter method, the working stresses specified for untreated timbers may be used, provided the strength is not less than about 87 per cent of that of untreated timber. Further investigation is necessary to determine proper working stresses for larger timbers or for those treated under higher pressures and temperatures or for greater lengths of time than are included in the tests reviewed in the paper.

Road Builders of North Atlantic States Discuss Problems

A Thousand Delegates From New England, New York, Pennsylvania, New Jersey and Delaware Consider Maintenance, Soil Tests, Aerial Surveys, Bypassing and Contractual Relations

Engineering News-Record Staff Report

REFLECTION of the new thinking in public roads engineering was clear in the dozen papers read at the annual convention last week at Syracuse, N. Y., of the Association of Highway Officials of the North Atlantic States. Stress was put on the broad engineering problems of bypassing cities and towns, on soil engineering and foundation design, on servicing traffic by extending maintenance, and on location and route planning from wide-area aerial maps. This note of broad engineering thinking was sounded in the president's address which opened the convention and continued through all the program of papers and discussions.

Speaking on the subject of being value minded in our highway engineering, Samuel Eckels, president of the association, pointed out that the problem today is to build for the future as we see it in the light of the present and the past. The problems we are considering today are those which will affect the motorist tomorrow, and we must calculate not so much what he does need as what he will need. If we are to meet those needs, we may not spend much of our time talking about what we have done—most of it must be occupied with what we shall do. Speaking of the township or local road Mr. Eckels stated:

> To build highways where none are needed is as costly a mistake as to build poor highways where good ones are required. If we let ourselves be swept from the rock of value mindedness by the high tide of enthusiasm, and embark upon a program of improving this mileage with concrete, none of us, nor our sons, would live to see its completion; nor, after its completion, would any derive the comfortable satisfaction of a task well done from the spectacle of a $1,000 farm on a $50,000 road.
>
> Approaching the problem from another angle, it is true that the light-type highway seems at first blush to offer the quickest relief to the farmer, both from the standpoint of building time and from the standpoint of financial limitation, on a most miles per dollar basis. Here again "value mindedness" will save us from another costly error. Highways, like any other factor subjected to the forces of wear and tear, can be operated under forced draft and overload. But forced draft and overload are terms which experience teaches us are inevitably followed by quick replacement, and replacement construction is the costliest kind in the end.

Discussing detour economics, W. A. Van Duzen presented an extension of the experience related in his article in *Engineering News-Record* Dec. 5, 1929, p. 884. He stated that the Pennsylvania Department of Highways is at the present time carefully studying the feasibility of using rich mixes and a 24-hour concrete for the last nine days' work of laying full width pavement while the contract is closed to traffic. It appears safe to assume, he said, that a rich mix with a normal mixing time of 1¼ minutes will yield service strength concrete in about six days. By the use of this method in reducing the curing period, in combination with a cement capable of yielding service strength concrete in 24 hours under normal curing conditions, it becomes possible to reduce the period of duration of the detour at least by nine days.

In a paper on secondary roads S. E. Fitch described the work done in Chautauqua County, New York, which in a succession of planned five-year programs has brought a large percentage of its road mileage into fine condition at low cost. Stage construction is practiced. The classes of roads are two-lane bituminous macadam, two-lane gravel, 10- to 12-ft. gravel and some one-lane concrete. Types of construction, however, were less important in developing the county system than were planned and scheduled improvement programs.

The organization and authority of testing laboratories were described by H. S. Mattimore. Outlining laboratory set-up and personnel, the speaker enlarged on the extension of testing laboratory responsibility beyond the mere testing of materials for acceptance to accountability for the quality of all materials entering into the road. This complete control would cost about 0.5 per cent of the construction cost.

Soil tests and treatment as determined by the elaborate studies of the Bureau of Public Roads were summarized by C. A. Hogentogler. Discussing the paper, W. F. Purrington stated that New Hampshire had established a soils engineering division and was now basing all road design on complete soils surveys. A paper by George E. Hamlin described experience in Connecticut with shoulder hardening by bituminous treatment. It has been found that all soils except clay and that even a sandy clay itself would take bituminous oils and would harden up into a very stable shoulder costing less to maintain and helping to preserve the travel way.

Two papers of particular importance were "Bypassing Cities and Villages," by H. W. Giffin, and "Aerial Surveys in Road Planning," by S. D. Sarason. Mr. Giffin presented lantern slide plans and aerial photographs of about a score of bypassing operations in New Jersey. Professor Sarason described methods and apparatus for aerial surveys and map making for various purposes. A discussion by T. M. Ripley described the full-county aerial map of Erie County and its use in route planning. The cost was about $90 a square mile. A paper and discussion on "Prequalification of Contractors" was presented by H. W. Wilson and E. P. Forrestel.

Progress in Sewage Disposal in Texas

Since 1913, when the Texas anti-stream pollution law was enacted, the state has progressed to the point where 90 per cent of the cities and towns have sewer systems where adequate treatment results are obtained. According to V. M. Ehlers, chief sanitary engineer, in a paper before the recent Texas Water Works Short School, there are 333 sewer systems in cities and 26 systems serving private and state institutions. Of this total number 90 per cent have provided some form of treatment so that practically all of the major streams and most of the minor tributaries in Texas are in good condition physically, chemically and bacteriologically.

Break in Downstream Dike at Saluda Dam Releases Segregation Pool

125,000 Cu.Yd. of Embankment Washed Away When Water From Core Pool Escapes Through Gap—Core Undisturbed Except at Outflow Trench

JUST at the time of change of shifts, 6:50 a.m. on Feb. 19, a 100-ft. section of the downstream dike of the Saluda hydraulic-fill dam, under construction near Columbia, S. C., slumped or broke out, releasing the water in the segregation pool. This water flowed out in about twenty minutes' time. Pool level was 324.2, or 169 ft. above the toe of the dam. The scouring action of the outflow washed out about 125,000 cu.yd. of embankment on the downstream side, but took out only about 1,000 cu.yd. of core material. No casualties resulted from the accident.

When the water rush was over, the slumped and washed-out area averaged 300 ft. wide and the outflow trench had a maximum depth of 45 ft. with a narrow 10-ft. gully in its bottom. As the break happened directly over the penstock pipes under the dam, the discharge was directed against the power house (under construction) and carried much mud into it.

The design of the dam was given in *Engineering News-Record*, April 25, 1929, p. 669. It is an 11,000,000-cu.yd. earth structure of 208-ft. maximum height, 7,838 ft. long on the crest, 1,150 ft. maximum thickness, and is being built by the semi-hydraulic method to form an impervious core roughly occupying the middle third. Materials going into the fill consist of decomposed granite gneiss, decomposed schist (hornblende), brown loamy clay, red clay and impure sand. The fill has been built up from trestles on the outer edges of the embankments in 25-ft. lifts.

At the time of the break the construction had reached

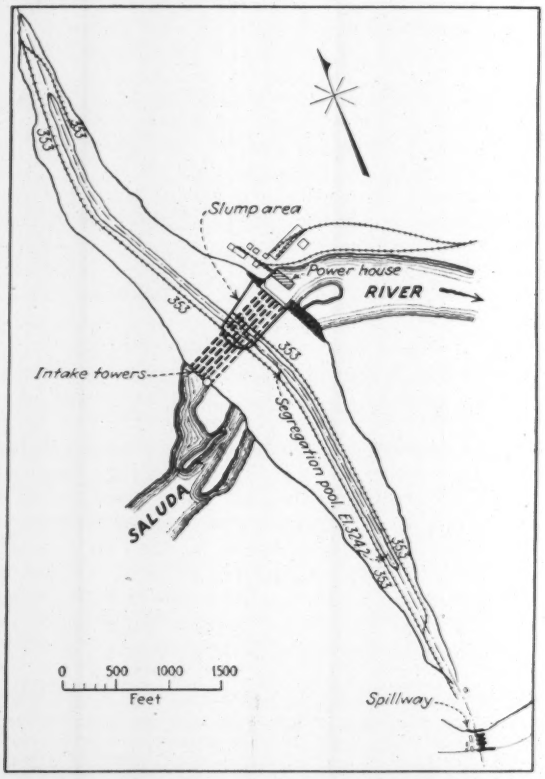


FIG. 3—GENERAL PLAN OF SALUDA DAM, SHOWING LOCATION AND EXTENT OF BREAK IN DIKE
Also shows extent of segregation pool and location of El. 353 trestles.

FIG. 1—LOOKING ACROSS BREAK FROM SOUTH END, SHOWING MOVEMENT OF EL. 353 TRESTLE DOWN THE EMBANKMENT TO THE RIGHT

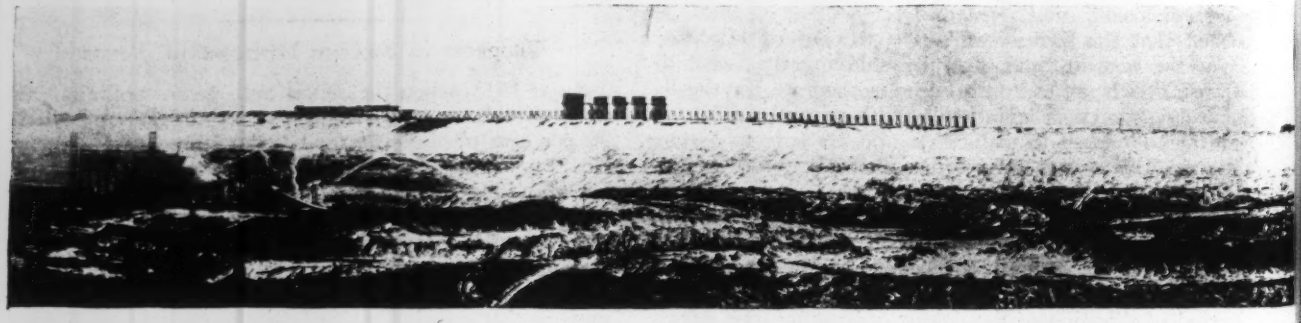


FIG. 2—PANORAMA OF SALUDA DA

View shows El. 353 downstream trestle being filled from south (left) and from north (extreme right). Power house under construction at lower left. Top of intake towers in background. Break in downstream dike occurred about

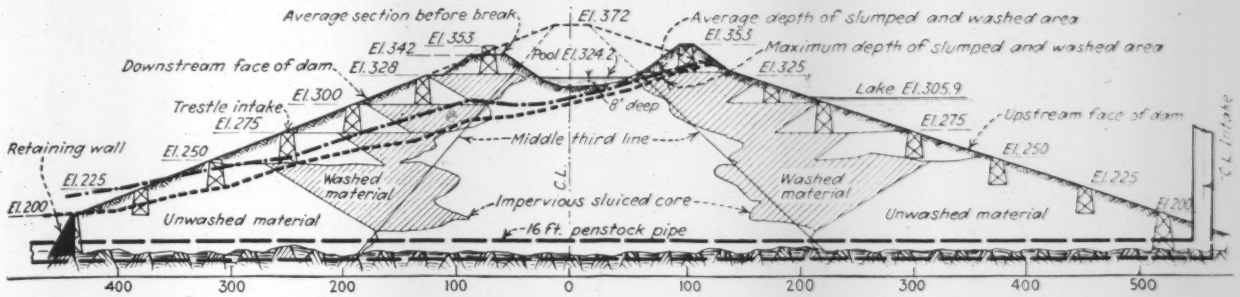


FIG. 4—TYPICAL CROSS-SECTION OF DAM SHOWING ULTIMATE SECTION, COMPLETED SECTION AT TIME OF BREAK, AND AVERAGE AND MAXIMUM PROFILES OF SECTION AFTER DISTURBANCE
Lower heavy dotted line is profile of deepest part of disturbed area. Upper heavy dotted line shows average profile of disturbed area.

the stage shown in Fig. 4. On the upstream side the entire length of the fill had been carried to El. 353, the full length of the dam. On the downstream side about half the length was up to 353, and dumping was in progress to complete this bank from the prior 328 level. The filling had been extended from the south end of the dam to a point about over the diversion conduit (Sta. 39) and the dumping trestle was completed several hundred feet northward. Between Sta. 39 and Sta. 36 the fill was being built up, sloping from El. 353 at Sta. 39 to El. 328 at Sta. 36, as shown in Fig. 6. No seepage was noticed through any part of the embankment previous to the break.

The segregation pool was over a mile long and averaged 8 ft. deep, with the surface at El. 324.2. Material is sluiced into this pool from the inner slopes of the dikes to form the core. Fig. 4 shows the limits of the sluiced core in a typical cross-section. The shaded area of this cross-section represents the material out of which the core was sluiced. This illustration also shows the amount of dumped material outside of the washed area that has not been disturbed by the jet action.

From Fig. 4 can be seen the cross-section of the dam before the break. The two heavy dotted lines show the average and the maximum profiles of the slumped and washed area after the break. It will be noticed from this cross-section that the bottom of the slump extends across the upstream dike, which slipped or slumped with about 14 ft. of vertical movement, apparently by its inside toe sliding into the hole washed out of the core at the center of the break. According to reports this slumping occurred some time after all the water had left the pool.

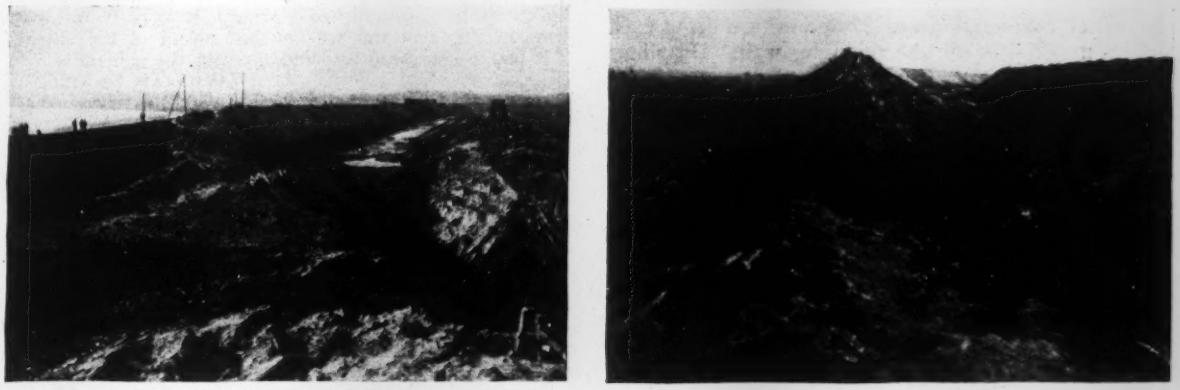
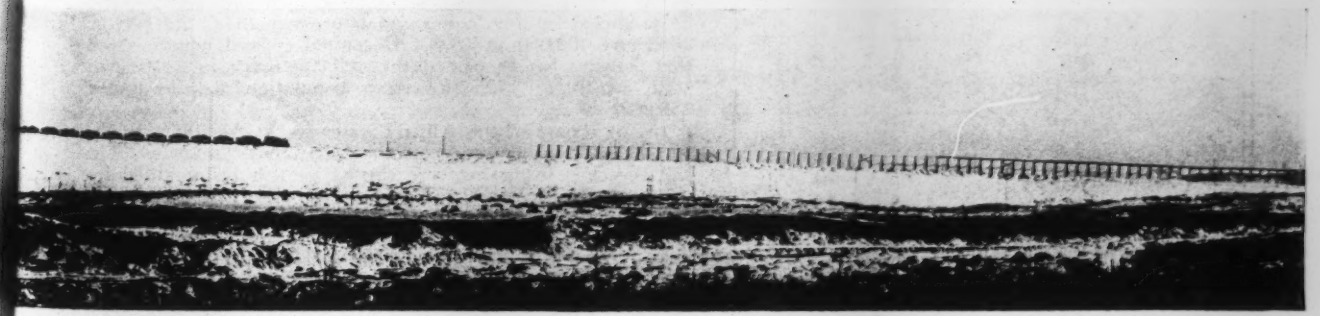


FIG. 5—TWO VIEWS OF BREAK LOOKING ALONG CENTERLINE OF DOWNSTREAM DIKE
Left: View looking northward. Right: View looking southward. Part of upstream dike that slumped into washed out hole in core can be distinguished, the light colored dike material showing against the darker core material. The freshly placed material on the upstream dike exaggerates the depth this dike slumped, as the fresh material has spilled over the original material in place. Note how sluiced core was undisturbed except at break.



AKEN FROM DOWNSTREAM JAN. 31, 1930
where freshly dumped earth appears on snow above power house, the fill having been extended northward from position shown. Ten million of the total 11,000,000 cu.yd. of fill required has been placed in the dam to date.

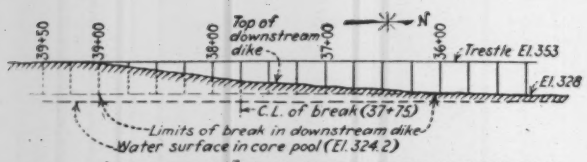


FIG. 6—LONGITUDINAL PROFILE OF DOWNSTREAM DIKE BEFORE BREAK, SHOWING RELATION OF BREAK TO PARTLY COMPLETED FILL

and not at the same time as the general slump. In Fig. 5 the light-colored dike material can be seen slumped down into the darker core material.

Filling the reservoir was started Sept. 1 last year, and has been carried on intermittently, the lake level having been at El. 300 (within a few feet) for four months; at present it is 305.9.

All reports agree that the 353 trestle toppled over inward, or toward the core pool. This trestle moved down the bank about 150 ft., as can be seen in Fig. 1, though part of it is washed completely away. Tracing the final location of the different trestles indicates that the first slump and washing took place in a narrow width, from 100 to 150 ft. The final break at core level is only about 100 ft. wide. Apparently after the first rush of water had scoured out a gully the adjacent embankment on both sides slid into the wash.

As can be seen from Fig. 5, the core stands undisturbed back of the break on each side. An indication of the small seepage through the core itself is shown by the fact that after the pool had all gone out, a 3-in. pipe was able to handle all of the seepage coming out of the core at the break.

Only a slight interruption in the construction schedule will be caused by the accident. Draglines are being used to reclaim material below the retaining wall. Draglines and shovels are pulling all of the disturbed and cracked embankment into the washed area, where it is being rolled into place. Additional material to make up for the volume lost will be brought in on stub trestles and rolled into place.

The project is being built for the Lexington Water Supply Co. by W. S. Barstow & Co. The Arundel Corporation is building the dam. Murray & Flood are engineers and Albert S. Crane is consulting engineer on the development.

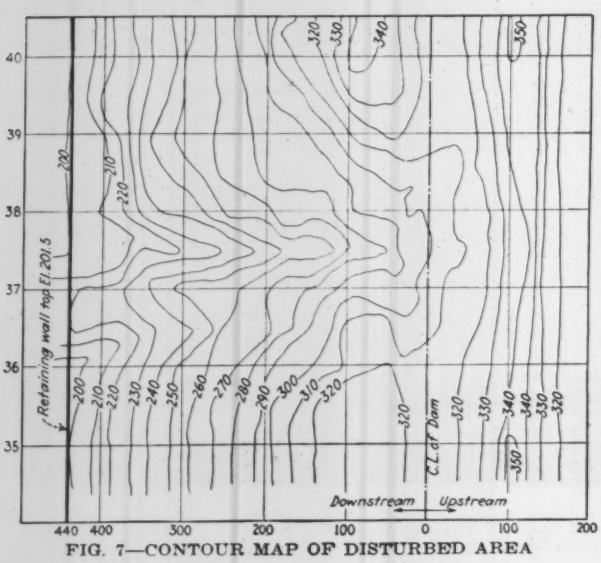


FIG. 7—CONTOUR MAP OF DISTURBED AREA

Letters to the Editor

Spiral Bridge Approach

Sir—In a note on the proposed New Orleans bridge in *Engineering News-Record* of Jan. 30, p. 205, the statement is made that spiral ramps have not been used in this country. Please stand corrected. A spiral ramp of one complete turn has been in constant use for several years as an approach to the Mississippi River bridge at Hastings, Minn., built by the Wisconsin Bridge & Iron Co. in 1895.

Milwaukee, Wis., J. F. JACKSON.
Feb. 11, 1930.

Rapid Tunnel Work at Detroit

Sir—The Northern Construction Co. & J. W. Stewart are doing the tunnel work that is under compressed air for the Detroit-Canada tunnel on both the Detroit and Windsor sides of the river. The shield is, roughly, 32 ft. in diameter, 16 ft. long, fitted with thirty 200-ton shoving jacks and twelve 25-ton platform jacks. The men are under the direct charge of Angus MacDonell.

On the Detroit side the shield was advanced several times the distance of 12½ ft. in 24 hours. With practically the same crew but with a little more experience, these men, now working on the Windsor side, have many times made 15 ft. per day, but on Feb. 4 they broke all their old records, making a progress that day of 17½ ft. in the 24 hours. This means handling by hand more than 570 cu.yd. of stiff clay, loading it, getting it through the locks, hoisting it up the shaft and loading on trucks. At the same time the excavation was carried on, 17½ lin.ft. of the steel segmental lining had to be erected and bolted up.

They are the best bunch of sandhogs I ever came in contact with, and it is a real treat to watch them work. We think they have established a record in work of this nature. None of this material was pushed ahead of the shield, all of it being excavated by hand through the shield.

WILLIAM SMAILL,
Chief Engineer,
Northern Construction Co. & J. W. Stewart.
West Rutland, Mass.,
Feb. 7, 1930.

Population, Lightning, Fish and Water-Works 80 Years Ago

Sir—Examination of old water-works reports often brings to light interesting population forecasts and surprising theories as to causes of unsatisfactory conditions of water being supplied, as the following will illustrate.

In a report on a water supply for Albany, N. Y., dated March 16, 1846, D. E. Douglas, "well and favorably known as an experienced engineer," analyzed the Albany census returns from 1790 to 1845 and found the yearly gain to vary from 3 to 6⅝ per cent and to average 4½ per cent. Based on a population of 41,138 shown by the 1845 census, he predicted by the "compound interest method" 200,000 in 1882 and 400,000 in 1898. Decennial federal counts show that Albany barely passed the 100,000 mark in 1910; the state census of 1925 showed a population a little under 118,000.

In the report of the Albany water-works for 1856, p. 55, the superintendent expresses the belief that "impurities" in the Bleecker reservoir were caused by fish being killed by a heavy thunderstorm. In support of this theory he says: "In an article on climatology published in the Patent Office Report for 1855 it is stated that 'when in 1670 lightning struck the Lake Zirknitz, 28 full wagonloads of fish were collected from the surface of the water for manure' and that 'in 1772, at Besancon, the water was covered with stunned fish.'"

CLINTON L. BOGERT,
Consulting Engineer.
New York City,
Jan. 25, 1930.

News of the Week

Safe Harbor Project Approved

That the Safe Harbor power project on the Susquehanna River falls under the federal licensing system was held at an executive meeting of the Federal Power Commission on Feb. 19. The commission granted permission to the Safe Harbor Water Power Corporation, of Holtwood, Pa., to proceed with its program of constructing a 231,000-hp. project 8 miles above Holtwood. The total cost of constructing this development was estimated at $30,000,000.

The question before the Power Commission, which had been holding up the Safe Harbor application, was whether the stream was navigable to the extent that the project was feasible under the federal water-power act. This the commission affirmed.

Steel Girders Buckle, Wrecking Coal Pocket in New York City

Failure of the structural framework supporting a new 3,000-ton coal pocket located on the bank of the Harlem River in the Bronx, New York City, resulted in the death of three men and the injury of eleven others on Feb. 21. The pocket was being filled for the first time, and the owner states that about 1,000 tons of pea coal had been put into it, when the southerly end collapsed. Examination of the wreckage shows that the webs of some 24-in. rolled-section cross-girders buckled, folding over completely. No other damage to the steelwork was apparent, other than that caused by the impact of debris and the twisting action of the steelwork as it fell.

The coal pocket consisted of a timber bin, 30 ft. wide east and west, between 35 and 40 ft. high and about 125 ft. long north and south, supported by a steel beam and girder framework resting on 12-in. H-section columns about 10 ft. high. The wrecked portion is 30x44 ft.—two bays 20 and 24 ft. along the east face and three 10-ft. bays along the south face of the building. The framing in an east-west direction consisted of 24-in. I-beams 10-ft. long, on top of which, framed in a north-south direction, were 18-in. I-beams in one bay and 14-in. I-beams in the other, all about 2½ ft. on centers. The top flanges of these 14- and 18-in. I-beams were brought to the same elevation by utilizing 4-in. I-beams in place of shim plates, these 4-in. beams running east and west along the edges of the flanges of the 24-in. cross-beams. The east-west girders rested on 1-in. cap plates and were lightly riveted and bolted to them. No diagonal bracing of any kind was used in the structure.

The results of the only investigation under way, that of the district attorney of Bronx County, have not as yet been announced. Examination of the steelwork shows the main failed members to have been the 24-in. girders, all of which folded over in the web, the top flange moving south. Whether this was caused initially from a coal slide inside of the bin, from the movement of columns from a foundation failure, from crushing of the 4-in. beam shims or from some other cause is not clear

P. & A. Photo

DIGGING FOR DEAD AND INJURED UNDER COLLAPSED COAL POCKET, NEW YORK CITY

from the evidence at hand. So far as can be ascertained, no permit for building the structure was issued. The bureau of docks, whose duty it is to examine all plans for waterfront property and to issue permits therefor, reports that application was made for a permit some time ago but that no permit was issued because some legal questions concerning property rights arose. The application was signed by the owner, the McNulty Bros. Coal Co., and listed Chris. Nilson, of Brooklyn, as the contractor. The fabricated steel was furnished and apparently erected by the Central Structural Steel Co., a Bronx concern. The designer of the steelwork, if there was one, cannot be learned.

Officers Chosen to Head Research Board of Engineering Foundation

At the annual meeting of the research board of the Engineering Foundation officers for the year 1930 were elected as follows: chairman, H. Hobart Porter, member Am.Soc.C.E., A.S.M.E., A.I.E.E. and A.I.M.E.; vice-chairman, Otis E. Hovey, Am.Soc.C.E., A.S.M.E.; director and secretary, Alfred D. Flinn, Am.Soc.C.E., A.I.M.E.; additional members of executive committee, Gano Dunn, Am.Soc.C.E., A.S.M.E., A.I.E.E., and George L. Knight, A.S.M.E., A.I.E.E.

Cracks in Domes of Coolidge Dam Found Not Serious

In a recent report to the Indian Service on the spillway capacity of Coolidge dam in Arizona, made by A. J. Wiley, F. A. Noetzli and Louis C. Hill, the existence of some leakage around the structure is noted as well as shrinkage cracks near the top of the two domes which abut against the canyon walls. The crack on the right dome starts at the rock abutment about 90 ft. from the top and is 60 ft. long. On the left dome a similar crack 30 ft. long starts about 50 ft. from the top. Both cracks are in a vertical plane parallel to the bridge and are open on the surface between ⅛ and ¼ in. The board considers the dam perfectly safe. Reservoir level is about half the full depth.

Tulsa, Okla., Votes $6,230,000 Bonds for Public Improvements

Tulsa, Okla., at a municipal election early in February, voted favorably on a city bond issue of $6,230,000. The bonds are to be issued in three series. The first, for $2,485,000, may be sold in 1930. Some of the contracts will be let early in April, Mayor Patmon announces. The proceeds from the sale of the bonds will be applied to street improvements, grade separations, bridges, sewers, airport, parks, fire stations, traffic signals and hospitals.

Wisconsin Engineers at Madison

A special "surveyors' day" marked the annual convention of the Engineering Society of Wisconsin, held at Madison, Wis., Feb. 19-21, and was the first step in a plan for a program varied enough to attract engineers from all fields. That regulation of engineering by law is bound to come in Wisconsin was stated by the president, L. F. Van Hagan, in his opening address. Although the society has made several unsuccessful attempts to secure such regulation, the demand has now grown to such proportions that regulation is not far away. Revision of the code of the state Board of Health governing the platting of lands on lakes and streams was explained by Frank King, and the surveyors were asked to co-operate in maintaining good sanitary conditions in the regions that have natural attractiveness as a summer playground, since health conditions can be greatly affected by the kind of platting.

A situation in which the surveyor is caught between conflicting rules was disclosed by H. S. Tuttle, of Phelps, Wis., who pointed out that the state Supreme Court, due to an error in

applying the rules of the U. S. General Land Office to a particular case, has laid down a rule for subdividing fractional sections that is contrary to the rule of the Land Office. Efforts will be made by the society to secure a change in the court ruling. Surveyors' day brought out the liveliest discussions. As to markers in the field, opinion favored the iron pipe over the concrete marker, and also favored plenty of markers. The present requirement that plats presented for registration be on muslin-back paper was scored as without merit. Attention was called to the fact that subdividers are subject to the rulings of numerous authorities, including the state Board of Health, town boards and city and regional planning commissions, which rulings are often in conflict.

Phenomena in regard to sand were demonstrated by Prof. Warren J. Mead, University of Wisconsin. A mixture of water and sand in a tight rubber bag was changed from a fluid consistency to a solid condition by simple pressure. As pressure changes the arrangement of the sand particles from close to open packing, in which condition the water is not sufficient to fill the voids, the mass assumes the properties of a solid. This feature was shown to have a bearing on the design of concrete, the treatment of foundation beds under dams and similar engineering situations. Geophysical methods of exploring underground conditions, as in revealing orebodies, were described by Prof. Warren Weaver.

Structural features of the new field house of the University of Wisconsin were explained by C. A. Willson, the designer. The familiar arch truss was discarded in favor of a cage type of construction that has a truss roof and vertical trusses to stiffen the walls. This design was dictated by the architectural treatment of the 70-ft. side walls, which called for walls much thicker than usual at the base. Investigation showed that the deflection of an arch would be great enough to crack the thick walls, and stiffening the arch by heavier design was found to be uneconomical as compared with the cage design.

Officers elected for 1930 include: president, Leon A. Smith, superintendent of water department, Madison, Wis.; vice-president, Walter A. Peirce, superintendent of water department, Racine, Wis.

Contracts Awarded for 48-Story Building in Cleveland

Erection schedules for the new 48-story Starrett Building, in Cleveland, Ohio, call for the completion of steel setting in 50 days at the rate of four stories in the first week and a floor a day thereafter. Starrett Bros., Inc., of Illinois, general contractor for the development, has let the steel contract for the building to the American Bridge Co. The contract calls for 15,000 tons of structural steel at a total cost of approximately $1,500,000.

Philadelphia Club Discusses Asphalt Paving Problems

New Developments in Airport and Road Work Include Improved Methods and Materials

CARRYING on its program of sponsoring annual meetings treating of particular phases of highway development, the Engineers' Club of Philadelphia on Feb. 18 discussed "Asphalt, Its Use in Highways and Airports." This subject was presented by a number of well-known engineers from the Eastern section of the United States in nine principal papers, which, together with the attendant discussion, occupied two sessions held during the afternoon and evening.

Maintenance of old paving by means of both repairing and resurfacing was described in two papers presented by Dudley T. Corning, chief of the Philadelphia Bureau of Highways, and R. A. MacGregor, engineer in charge of the division of maintenance, Borough of Manhattan, New York. The increasing magnitude of this problem is evidenced by the fact that Philadelphia since 1927 has expended approximately $2,500,000 for resurfacing 200 miles of pavement and that resurfacing of both sheet asphalt and asphalt block pavement in the Borough of Manhattan now totals approximately 250,000 sq.yd. per year.

Airport Runways

Surface treatments for airports as applied at Curtiss Field, Valley Stream, L. I., and at Central Airport, Camden, N. J., were described in a paper prepared by J. A. Feely, of the Atlantic Refining Co., who stated that an airport surface must be: (1) dustproof; (2) waterproof; (3) resilient to reduce impact; (4) pliable, so that tail skids can cut in; (5) self-healing to reduce cost of maintenance. After considerable study of conditions at Valley Stream the company decided on a treatment of Mexican asphalt of 85-100 penetration applied at approximately 300 deg. An area 600 ft. square was treated.

Perry Fellows, city engineer of Detroit, Mich., presented a paper, "Asphalt Pavements for Airport Construction," by title only, commenting upon certain features of it before the meeting. He stressed the fact that the efficient development of airports is an engineer's task and that the selection of proper sites and materials for runway treatment is a matter which calls for the engagement of expert talent, in order to obtain the best possible return for the expenditure. Detroit has spent $282,000 on paving of all kinds, including waterbound macadam, concrete and two-course bituminous concrete.

Relative advantages and disadvantages of the many types of asphalt pavements designed for laying cold were thoroughly outlined by Allen W. Dow, of Dow & Smith, New York City. These materials were classified by Mr. Dow as follows: (1) natural rock asphalt; (2) Amiesite and related materials; (3) cut-back asphalts; (4) asphalt emulsions; (5) Colas and Bitumuls; (6) MacAsphalt. Mr. Dow described the methods of preparation and of application of these pavements in great detail. Discussion of his paper was initiated by M. H. Ulman, assistant engineer of materials, Pennsylvania State Highway Department, who summarized the results obtained in that state with experimental strips of various cold-laid pavements.

Design Problems

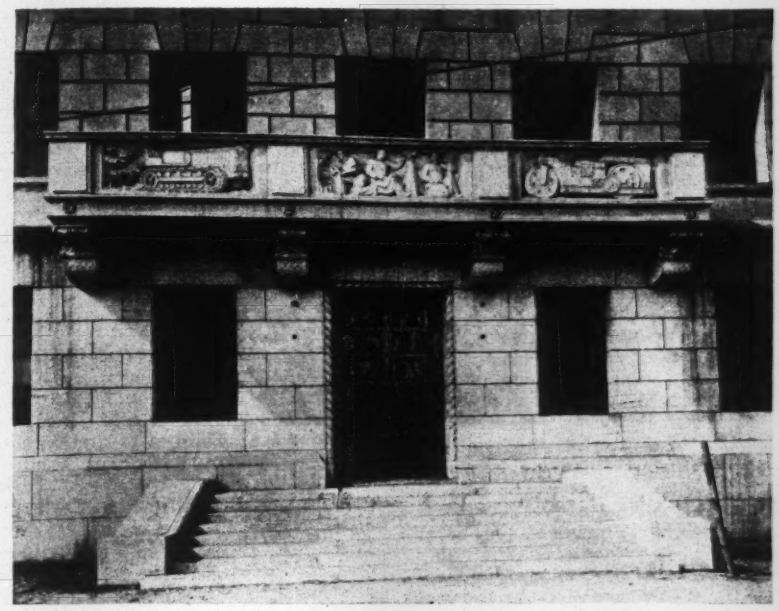
A paper on the general principles of design for pavement foundations, applicable not only to asphalt pavements but to others as well, was presented by A. T. Goldbeck, director of the bureau of engineering, National Crushed Stone Association. Developments in the design of asphalt mixes were treated in detail by Prevost Hubbard, of the Asphalt Institute. The subject was introduced by Julius Adler, consulting engineer, of Philadelphia, who stated that the average specification for this type of pavement is unsatisfactory because it contains wide variations which leave too much to individual judgment.

Design of asphalt mixtures was elaborated upon by Mr. Hubbard, who described the experimental work done by the Asphalt Institute in search of a satisfactory method of proportioning materials used in asphalt pavements. The method finally evolved is fully described in publications of that body and consists essentially in balancing proportions so as to obtain sufficient stability without at the same time decreasing the durability of the pavement. The two requirements are to some extent contradictory, in that superior stability is obtained with a low percentage of bitumen, but too great reduction in this amount involves a tendency to crack, with early deterioration of the pavement.

Mixing, Finishing and Costs

That the best-designed paving can be ruined in a few seconds in the mixing plant was emphasized by J. W. Davitt, of the New Jersey Asphalt & Paving Co., Jersey City, who has evolved a method of eliminating the human equation by automatic electrically operated gates to secure uniform mixtures. These are actuated by contacts at the scales. The advantages of the newly developed screed type of finishing machine for asphalt pavements were described by C. L. Donovan, of the Lakewood Engineering Co., Cleveland, Ohio. The machine rides on forms or the curb and can be adjusted for different widths.

Valuable data on the cost of asphalt pavements in municipal service were given by R. H. Simpson, chief engineer of the department of public service, Columbus, Ohio, who presented de-



MEN AND MACHINERY HONORED BY PENNSYLVANIA

Decorations on the newly completed State Highway Building at Harrisburg, Pa., commemorating the work of men and machinery in the construction of state highway systems. The two end plaques picture modern road-building machinery; the center, the men who build the roads.

tailed figures on the cost of asphalt paving in Columbus under typical municipal conditions, emphasizing the importance of his records by stating that the era of maintenance is just starting. In Ohio alone, approximately $30,000,000 was expended for this purpose last year. Interesting facts brought out during the address were that, in Columbus, 21 per cent of the pavement carries 81 per cent of the traffic at 52 per cent of the cost; that asphalt pavements will last as long as 35 years with moderate repair costs under favorable conditions; that the repair cost per square yard of pavement increases, as might be expected, with the age of the pavement, with a distinct peak during the tenth, eleventh and twelfth years; and that the oldest asphalt pavement in his city, laid in 1888, is still in service, with the recorded repair cost of 4c. per square yard per year for the 41-year period.

H. W. Hughes, substituting for Henry L. Howe, of the department of public works, Rochester, N. Y., described that city's municipal asphalt plant and its organization for maintaining pavements in proper condition.

Toronto Studies Transit Problem

Subways are being considered by the city council of Toronto, Canada, which has asked the Toronto Transportation Commission for a report on the feasibility and possibility of a tube system for that city. Tubes for rapid transit have been considered officially in the past on at least two occasions, without action being taken. In 1911 a proposal to spend more than $5,000,000 on an underground railway from the harbor front to the northern part of the city was placed before the ratepayers in a bylaw which met defeat. Rapid-transit problems again came to the front in 1915, when an exhaustive report was prepared by a group of eminent engineers, but at that time rapid transit, in the true sense of the term, was not considered as warranted in cities under 1,000,000 population. Toronto is growing rapidly both in population and industrial importance, and the reopening of the tube question comes at a time when comprehensive town planning proposals are under consideration for the extension and widening of streets to take care of traffic congestion.

Chicago Traffic Plans Discussed

Regulation of street traffic and protection or elimination of railway grade crossings were the main subjects at the recent annual meeting of the Chicago Regional Planning Association. The relation of old trails, new subdivisions and the ubiquitous automobile to street traffic was presented by L. J. Sorenson, city traffic engineer, while the various kinds of traffic control at intersections, suitable to different conditions of traffic, were reviewed by E. J. McIlraith, engineer for the Chicago street railways. In a paper on railway grade crossings, by J. R. Blackhall, general manager of the Chicago, North Shore & Milwaukee Electric Railway, stress was laid on the small proportion of accidents at such crossings as compared with those at street intersections and other points. From this it was argued that more attention should be given to the protection of other places than track crossings. The remainder of the program included papers on the legal aspects of zoning; the proposed Chicago harbor development, by R. W. Putnam, consulting engineer, and a metropolitan system of airports by Major-Gen. John F. O'Ryan. As officers for 1930, the association again re-elected D. H. Burnham and Robert Kingery as president and secretary respectively.

Chicago Selling Tax Warrants to Its Citizens

A taxpayers' trust has been organized in Chicago by a citizens "rescue" committee to handle subscriptions of small and large taxpayers to a fund of $74,000,000 with which to buy 1930 tax anticipation warrants of the city, county, school board and sanitary district. This sum is required for the operation of these local governments up to July 1, by which time it is hoped funds from the 1928 taxes may be available. Drives by industries and professions like a Liberty Loan drive have been organized, with $500 as the smallest denomination available. Some 44,000 city, county and school employees have nearly $12,000,000 in overdue salaries accumulated since last December.

I.C.C. Considers Proposed New Western Rail Lines

To stimulate the development of the Spruce Mountain mining district in Nevada, the Sprucemont Nevada Railroad has been granted authority by the Interstate Commerce Commission to build an extension from a main line connection with the Western Pacific Railroad at Ventosa, 23 miles south to Sprucemont. Cost of construction is estimated at $375,390. The immediate purpose of the line is to provide an outlet for lead-silver ore produced by the Missouri-Monarch Consolidated Mines Co., the Nevada Lead & Zinc Co., the Spruce Standard Mining Co. and the Big Missouri Mining Co. Only high-grade ore now is shipped because the excessive cost of transportation prohibits the movement of lower grades. The railroad has been granted permission to retain earnings derived from the line in excess of 6 per cent.

New construction proposed by the Western Pacific to draw traffic for its transcontinental route from the Joaquin Valley in California has been disapproved by the commission. As presented to the commission, the plan of the Western Pacific proposed construction of several segments of track to form a continuous line about 138 miles long extending up the Joaquin Valley from a connection with the Western Pacific at Nilegarden, about 11 miles south of Stockton, to a point on Kings River about 21 miles southeast of Fresno. An intermediate portion of the route is covered by the line of the Tidewater Southern, a subsidiary. The construction cost of the proposed line was estimated at $8,352,557. The commission held that the needs of the Western Pacific do not justify the inherently waste-

ful paralleling of existing railways that would result from construction of the line. The Joaquin Valley now is traversed by three parallel lines of road owned by the Southern Pacific and the Sante Fe.

Construction of 76 miles of new line from Vega, Tex., to Forrest, N. M., at a cost of $2,250,000 is proposed in applications filed with the commission by the Chicago, Rock Island & Pacific.

Applications to build two railroad extensions to serve the oil field at Van, Van Zandt County, Tex., have been filed with the commission, one by the St. Louis Southwestern of Texas and the other by the Texas Short Line, subsidiary of the Texas & Pacific Railway.

To Start Dredging Channel of San Joaquin River

Bids for dredging the first unit of the deep-water channel project of the city of Stockton, Calif., have been called for by the Sacramento office of the Corps of Engineers. Plans for the project, which were outlined in *Engineering News-Record* Feb. 26, 1925, p. 372, provide for a channel 92 miles long, 100 ft. wide at the bottom and 20 ft. deep at low water. The route will follow the San Joaquin River, which will be widened and straightened. The entire project will cost approximately $6,000,000 and should be finished in about three years. Funds now available include a $3,000,000 bond issue of the city of Stockton, a $2,407,500 appropriation by the federal government and $510,500 provided by the State of California. The first unit, for which bids are now being received, extends from Suisun Bay to Pittsburg, Calif., 2½ miles, and is expected to cost approximately $91,500.

Tacoma Prepares for Third Hydro-Electric Project

Filings have been made on behalf of the city of Tacoma, Wash., with the state hydraulics office, contemplating a hydro-electric municipal power development on the upper reaches of the Cowlitz River. The new project is designed to supplement the city's Lake Cushman and Nisqually River plants now in operation. The plant includes the diversion of 125 sec.-ft. of water from Clear Fork stream into Packwood Lake in Lewis County, by means of a 10x12-ft. tunnel, 5.4 miles long, and the impounding of 65,000 acre-ft. of water in the lake by means of a rockfill dam 105 ft. high and 600 ft. long. The cost of the tunnel is estimated at $1,500,000, and that of the reservoir at $750,700.

The application seeks the appropriation of 250 sec.-ft. of water from Lake Creek to be conveyed to the power plant by means of 16,000 ft. of tunnel and 6,000 ft. of pipe line, this work and the generating plant to cost approximately $6,120,000. The entire project is estimated to cost $8,375,000.

California Water Suit Decided

After extended litigation Judge Lacey D. Jennings, of the Superior Court of San Diego County, Calif., on Feb. 10 rendered his decision in the water case involving the division of the total flow of the Santa Margarita River, amounting to about 30,000 acre-ft. per year, between two large ranches, the Rancho Santa Margarita y las Flores and the Pauba-Temecula Rancho. The court awarded 76 per cent of the total river flow to the Rancho Santa Margarita and 24 per cent to the Pauba-Temecula.

Although no new legal principles were established by the decision, as the conflict was regarding facts and conclusions to be drawn from the facts, the case had attracted wide attention. Final allocation of the water was based upon expert testimony as to the quantity of riparian land, duty of water, length of the stream, volume of water, extension of ownership, character of soil, area of contemplated irrigation, practicability and expense of irrigation, profit from practical crops, limitation to most profitable use, climate, location and altitude of irrigable lands, nature of crops and length of irrigation period and growing season each year, all of which had to be considered according to California law.

Trial of the case was begun Oct. 18, 1926, and concluded Feb. 28, 1929, since which time Judge Jennings has been continuously at work on the briefs, transcripts of testimony and exhibits and in writing his decision, which required a whole day to read. There were 55,171 typed pages of reported transcript and 2,201 exhibits, consisting of maps, graphs, tabulations, profiles, hydrographs, photographs and geological samples. Of 444 actual court days of taking testimony, 121 days were consumed in the direct evidence and cross-examination of F. C. Finkle, expert engineering witness for the Rancho Santa Margarita. The cost of the case is estimated at $1,000,000.

The Business Outlook

Building, except public work and utilities, so far shows little sign of marked advance, which may perhaps be discounted on seasonal grounds. But car loadings and check money turnover are still lagging. The unexpected commodity price deflation since the market crash has apparently given a second and more serious shock to business itself. This is a deferred result of credit restriction a year ago, which still persists. To offset it and hasten business recovery, prompt further easing of money is necessary.

Automobile steel demand is increasing steadily. It is expected that February will show at least a 10 per cent increase over January production. Bituminous coal production is considerably below last year. The January report of consumers' stocks, 40,300,000 tons, indicates that the high output of the last few months of 1929 was going into stocks rather than into consumption.
—The Business Week, Feb. 26.

Track Elevation for Montreal Approved by City

After much discussion revolving around the possibilities of underground trackage, the city council of Montreal has finally approved plans of the Canadian National Railways for elevated tracks between St. Henri and Point St. Charles. The terminal project came before the Canadian Parliament last year, when authority was given to the Canadian National to expend up to $50,000,000 on the Montreal terminals. It is expected that $10,000,000 will be spent during the present year and that a substantial amount of the work will be undertaken at an early date. The problem of excavating and disposing of some 3,000,000 cu.yd. of earth and rock is one which faces the engineers. Excavation work in connection with the provision of station trackage at the present tunnel terminal site alone will involve the removal of 1,100,000 cu.yd. of earth and rock, since the present trackage must be extended to provide for the needs of the increased traffic which will be handled through the Mount Royal tunnel and by other means of ingress to the new terminal.

Canadian Projects Authorized

Two important water-storage projects in the Province of Quebec have just been authorized by the Quebec Streams Commission. They are located on the Mattawin, a tributary of the St. Maurice River, and on the Lievre River. The Mattawin project, to be undertaken by the Shawinigan Water & Power Co., will be located at the head of the Bull Rapid, some 25 miles from St. Michel des Saints, and will be a regulator for the supply of water gathered in a basin some 1,600 square miles in area. The additional flow will raise the St. Maurice's quota by 1,000 sec.-ft. to a total of 18,000. The work on the Lievre River is being undertaken by the James MacLaren Co., of Buckingham. A hydro-electric development near Buckingham will be fed from a dam at Cedar Rapids. Waters in White Fish Lake, and the river down as far as the Wabasee Rapid, will be included in the new storage. The power house will be at High Falls, some 30 miles from Buckingham, where there is a fall of approximately 120 ft., and will develop 90,000 hp.

Brief News

CONSTRUCTION OF A MUNICIPAL POWER PLANT at Rome, Ga., has been authorized by the city commission following a controversy with the Georgia Power Co. Citizens petitioned the commission to levy a straight tax on all the people for a period of years rather than issue bonds for the construction of the plant.

CONTRACT FOR THE CONSTRUCTION of an extension of the Timiskaming & Northern Ontario Railway has been awarded to H. F. McLean, Ltd., of Toronto. This section will extend from Coral Rapids to Moose River, a distance of 45 miles.

ERECTION of a 25-story building to house the Seattle city light department will be voted on at an election to be held in March. The structure, which would cost almost $2,000,000, would be built by a group of local architects and promoters and leased to the department for a 50-year term, after which title would pass to the city.

CONCRETE ROADS are becoming increasingly popular in Europe. In 1926 the total mileage of continental highways constructed of this material was only about 300 miles, while in 1929 approximately 3,000 miles were built. A further increase is expected during 1930.

THE GERMAN GENERAL ELECTRIC Co. has formed a subsidiary firm at Dublin, Ireland, for the construction of power plants and transmission lines in that country.

WATER FROM WELLS for supplementary irrigation purposes in the Willamette Valley of Oregon will be the subject of study by the state experimental station, a fund of $7,000 having been collected from industries in the state to finance the experiments.

A CANAL between Liége and Antwerp will be constructed by two German firms at a contract price of approximately 400,000,000 francs. This is the largest contract placed by a foreign government with a German firm since the war.

RUSSIA WILL BUY 50,000 tons of foreign pipe for the construction of a second oil line from Batum to Baku, construction on which is planned for the latter part of 1930. An extension to Moscow is also planned, but no definite date has been set for starting this work.

FIVE STEEL BRIDGES will be constructed during 1930 on the main line of the Canadian Pacific Railway between Vancouver and North Bend, B. C. Completion of these structures will give the railway modern structures on every major crossing along the main line across the country. During the past two years 24 steel spans have been completed in British Columbia to accommodate the heavier locomotives now used.

WASHINGTON NOTES

By PAUL WOOTON
Washington Correspondent

Approach Solution of Water Dispute—Army Engineers Need Funds—Rail Merger Approved

AGREEMENT between the California factions as to the division of waters from the Boulder Canyon project has been reached after a series of meetings held last week in Los Angeles. Of the 4,400,000 acre-ft. allotted to California from the class A main stream waters, the agricultural group—that is, the Imperial Valley—is to get 3,850,000 and the Metropolitan Water District 550,000. From the unapportioned surplus, the district will receive an additional quantity up to 550,000. Any remaining surplus available to California over this 1,100,000 acre-ft. will go to the Imperial Valley. Apparently Arizona's stake in the surplus might reduce the Metropolitan allotment to 1,050,000 after the ultimate developments for use have been made, but this is an eventuality of no present consequence.

This agreement seems to clear up the situation as concerns division of water. The allocation will supply drinking water to 7,200,000 people, according to estimates, and irrigation to 140,000 additional acres now semi-arid. No further action is reported on power allocation.

Progress on Boulder Dam Plans and Surveys

In the deficiency bill recently reported to the House, an appropriation of $175,000 is recommended for the Bureau of Reclamation in connection with the Boulder dam project. This money is necessary to permit the completion of plans and the making of surveys of the dam site and of the all-American canal. Testimony by officials of the Reclamation Bureau before the appropriations committee disclosed that $70,000 of the amount asked will be used to enable the engineers to continue the preparation of the plans, specifications and designs for the town, for the dam and for the power plants. The committee was also informed that $15,000 will be used for topographic mapping and for the establishment of gaging stations to carry on measurements of the river at the dam site. It was explained that the topographic mapping will be done by the Geological Survey. The sum of $15,000 is requested for the operation of a temporary laboratory for testing materials which has been established already at Las Vegas.

Control of Water Resources

Creation of a water resources commission consisting of a chairman to be appointed by the President and the Secretaries of War, Agriculture and the Interior is proposed in a bill that has been introduced by Representative O'Connor, of Louisiana. This bill has been referred to the committee on interstate and foreign commerce. The general purpose of the measure is to bring about co-ordination of the varied governmental activities pertaining to control and development of the nation's water resources. This would include flood control, reclamation, irrigation, water-power development and improvement for navigation.

To carry out the purposes of the proposed act, an appropriation of $7,500,000 is recommended to be used in defraying the expenses of securing engineering reports and surveys. Another appropriation of $2,500,000 is provided to be used in the preparation of a comprehensive plan for the control of floods on the entire Mississippi watershed.

Advice Requested on Illinois Waterway

Whether the Lakes-to-the-Gulf waterway project will be taken over by the federal government and rushed to early completion will depend to a large extent on a report that is being prepared by the rivers and harbors board of the Corps of Engineers. Before sending this report to Congress the army engineers have requested the opinion of the Department of Justice on some of the legal points involved. Those sponsoring the project believe that the War Department would be more likely to recommend the undertaking if some of the legal questions were cleared up. These concern the protection that would be afforded the United States in case the voters of Illinois decide to disapprove the action of their state officials in turning over their portion of the waterway and the extent to which federal navigation laws would apply in the locks that virtually have been completed by the state.

The report on the feasibility of nationalizing the project that was submitted by the army engineer office in Chicago is known to be favorable.

Funds for Rivers and Harbors

Upon the recommendation of the Secretary of War, the President has approved the supplemental estimate submitted by the Chief of Engineers for $12,000,000 for maintenance of existing river and harbor works during the fiscal year 1930. It is planned to attach this appropriation to the deficiency bill now pending before the House. In commenting upon the situation, the Secretary of War pointed out that the river and harbor work has been speeded up to relieve some of the distress caused by the stock-market crash by providing a greater amount of public employment.

As a result of this accelerated program the expenditures during the first half of the fiscal year of 1930 have averaged more than $6,050,000 per month. This present rate of expenditure is materially in excess of annual appropriations. The accumulated balance from former years when work was not pushed so energetically has made these extra expenditures possible. Secretary Hurley pointed out, however, that the present rate of operations cannot long continue unless the supplemental appro-

priation is authorized by Congress. The regular War Department appropriation bill, which contains $55,000,000 for river and harbor work, is being delayed in the Senate, he said.

Northwestern Rail Lines Merge

Divorce of the Burlington is the price stipulated by the Interstate Commerce Commission for permitting unification of the Great Northern and Northern Pacific railways. The commission's decision was anticipated by exclusion of the Burlington from the Great Northern Pacific system as outlined in the commission's consolidation plan. In refusing to permit control of the Burlington to pass into the hands of the Great Northern Pacific Railway, the commission remarked that it is not deciding now the question whether the Northern lines should be denied a permanent entrance into the Chicago district. The record will be held open until the Northern lines have presented a plan for the divestment of their joint control of the Burlington, a plan for the inclusion of necessary short lines allocated to the Great Northern Pacific system by the commission and a statement of their policy with respect to the unified operation of terminals. Lease of the Spokane, Portland & Seattle by the new company is contingent upon granting trackage rights to the Chicago, Milwaukee, St. Paul & Pacific between Portland and Seattle.

Personal Notes

B. W. MATTISON, senior highway engineer for the federal Bureau of Public Roads for Utah and Idaho, has been made regional director of the bureau, with headquarters at San Francisco, succeeding W. N. Frickstead, who has resigned to become city engineer of Oakland, Calif.

CLARENCE M. BLAIR and ORSON H. MARCHANT, associated for the past 25 years with the late Albert B. Hill, consulting engineer, New Haven, Conn., have acquired Mr. Hill's records and files and will engage in general consulting and engineering practice as Blair & Marchant, Inc., with offices in New Haven.

GEORGE L. OPPER has been admitted to partnership in the engineering firm of Marr, Green & Co., Chicago, and the firm's name has been changed to Marr, Green & Opper.

JESSE M. SHELTON and MCQUEEN AULD, both associated with Robert & Co., architectural and engineering firm, have been advanced to vice-presidents of that organization and Mr. Auld has been made manager. Both men are graduates of the Georgia School of Technology.

GUY B. BEOUT, connected with the United States Engineer's office at Wheeling, W. Va., for the past fourteen years, has succeeded the late A. M. Todd as principal engineer of the Vicksburg district. Mr. Beout is a native of West Virginia and received his technical training at the University of Ohio, where he was graduated from the engineering department in 1895.

LAYSON E. ATKINS, major, Corps of Engineers, has been ordered relieved from duty as assistant to the engineer commissioner of the District of Columbia, and directed to proceed to Juneau, Alaska, about May 28 for duty as a member and engineer officer of the board of road commissioners for Alaska.

CHARLES KIEHM, architect and engineer, of Utica, N. Y., is to become superintendent of the reorganized department of buildings. Mr. Kiehm is a graduate of the University of Pennsylvania and for several years was in the state engineer's office at Albany, N. Y. He has had an office in Utica since 1911, and many of the textile plants in that city were designed by his office.

W. D. WILLIAMS has been appointed division engineer of the Cleveland, Cincinnati, Chicago & St. Louis Ry., with office at Van Wert, Ohio.

W. J. B. SMITH, of Dayton, Wash., has been elected county engineer of Franklin County, Wash., to succeed C. W. Carter, resigned. Harold Blanton has been elected assistant engineer.

Society Calendar

AMERICAN RAILWAY ENGINEERING ASSOCIATION, Chicago; annual meeting, Chicago, Ill., March 11-13.

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia; regional meeting, Detroit, Mich., March 19.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York; spring meeting, Sacramento, Calif., April 23-24.

AMERICAN WATER WORKS ASSOCIATION, New York; annual meeting, St. Louis, Mo., June 2-6.

AMERICAN WELDING SOCIETY, New York; annual meeting, New York City, April 23-25.

CONCRETE REINFORCING STEEL INSTITUTE, Chicago; annual meeting, Augusta, Ga., March 3-April 2.

INTERNATIONAL CONGRESS OF BUILDING AND PUBLIC WORKS, London, fifth congress, London, England, May 26-30.

INTERNATIONAL RAILWAY CONGRESS, Madrid, Spain, May 5-15. American vice-president, T. S. Morgan, 119 West 42d St., New York.

WORLD POWER CONFERENCE, second plenary meeting, Berlin, Germany, June 16-25. American secretary, O. C. Merrill, Washington, D. C.

CANADIAN SECTION, American Water Works Association, will hold its annual meeting March 12-14 at Hamilton, Ont.

CONNECTICUT SOCIETY OF CIVIL ENGINEERS held its annual meeting Feb. 18-19 at New Haven. Officers elected are: president, Albert L. Donnelly, New Haven; vice-presidents, Elmer C. Welden, Hartford, and H. Jackson Tippet, New Haven. Clarence M. Blair, New Haven, was re-elected secretary-treasurer, and Joseph D. Kelleher, New Haven, was chosen assistant secretary. Honorary membership was conferred upon J. Frederick Jackson.

ENGINEERING COUNCIL OF UTAH, Salt Lake City, has elected the following officers for the ensuing term: president, Charles R. Higson, superintendent of distribution for the Utah Power & Light Co., succeeding George M. Bacon; secretary and treasurer, John Salberg (re-elected).

MATERIALS HANDLING will be the subject of a special meeting of the American Society of Mechanical Engineers to be held March 5-7 at Chicago in conjunction with the National Industrial Exposition of material-handling equipment.

NEW YORK STATE CHAPTER, Associated General Contractors, highway division, will hold its annual convention March 12-13 at Syracuse, N. Y.

ROCKY MOUNTAIN SECTION, American Water Works Association, in session at Denver Feb. 13 and 14, elected the following officers: chairman, F. C. Osborne, city engineer, Loveland, Col.; vice-chairman, G. C. Culberson, Ratin, N. M.; secretary-treasurer, D. E. Kepner, Denver (re-elected). Features of the convention were addresses by J. P. Richards, consulting chemist, of Denver, on corrosion as the most serious problem confronting municipal water departments, and an inspection trip to study the sewage-treatment plant in Aurora, a suburb of Denver.

Obituary

JOHN MOLONEY, for 24 years an engineer in the Department of Water Supply, Gas and Electricity, New York City, died on Feb. 15.

WILLIAM F. HARDEN, president of the Harden Contracting Co., of New York City, died on Feb. 23, aged 68. Mr. Harden had been a contractor in New York for nearly half a century. He supervised the demolition of the 42d St. spur of the Third Ave. "El," built the elevated section of the Queens subway through Elmhurst, and constructed and sank the caissons for the subway tubes beneath the East River.

CHARLES SAVILLE, former health director of Dallas, Tex., and former manager of the Chamber of Commerce of that city, died on Feb. 15 at the age of 47, following an operation performed several weeks previously. Mr. Saville's best-known work was in mosquito control in eradicating malaria from Dallas and the towns along the Cotton Belt railroad. For the past few years he has been in the insurance business. He was educated at Harvard, at the Massachusetts Institute of Technology and at colleges in Germany.

FRANK M. WILLIAMS, formerly New York state engineer and a member of the Interoceanic Canal Board, died at his home in Albany on Feb. 20. He was 57 years old. Mr. Williams was elected state engineer in 1909 and was re-elected four times, and one of his most outstanding achievements was the reconstruction of the Erie Canal as the New York Barge Canal. As a member of the Interoceanic Canal Board, appointed by President Hoover, he was to help decide whether the Nicaraguan Canal project should be carried through or the Panama Canal be enlarged. Mr. Williams was a consulting expert to the New York and New Jersey State Bridge and Tunnel Commissions on the building of the Holland tunnel. In 1910-11 he was chairman of the Barge Canal Terminal Commission to investigate canal harbors. He was a member of the American Engineering Council, representing the American Society of Civil Engineers.

Construction Equipment and Materials

New Corrosion-Resisting Metal

Numerous advantages over ordinary galvanized sheets are claimed for the new Gal-Van-Alloy steel sheets recently placed on the market by the Inland Steel Co., of Chicago, Ill. The coating on these sheets is completely alloyed with the base metal, there being no top layer of pure zinc, as is the case with regular galvanized sheets. On this account it is claimed that Gal-Van-Alloy sheets will withstand severe drawing or forming operations without peeling or flaking, and that this material will also stand considerably more heat than galvanized sheets without flaking or cracking of the coating. The finished surface of a "Gal-Van-Alloy" sheet is considerably smoother, reducing the usual peeling or cracking after painting, enameling or lacquering. The sheets are dull gray in appearance and can be supplied in 16 to 30 gage inclusive. They are made in two grades, regular and special, the latter having a much smoother surface than the regular grade. They may also be had with a copper alloy steel base, which is recommended where maximum corrosion-resisting qualities are desired.

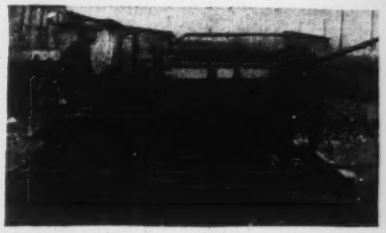
Caving of Trench Prevented by Traveling Supporter

Lateral support to newly dug trenches without the use of sheathing is provided by a new machine announced by the Greiman Ditcher Co., Minneapolis, Minn., known as the Greiman trench supporter. The main purpose for which this unit is designed is the laying of pipe in conjunction with the use of the standard ditching machine. It consists of a pair of heavy steel plates which are lowered into the trench by power, either end independently, by means of racks and pinions. A crawler unit on the bottom of the machine, in combination with two crawler units on the sides, propels the outfit along the trench at a speed which may be regulated from 6 in. to 8 ft. per minute, corresponding to the speed of the trencher. Power is provided by a heavy-duty four-cylinder motor contained within the machine. After being lowered into the trench, the sides are expanded by a hand wheel until the side crawler units come into contact with the sides of the trench. The width of the supporter normally is 24 in., which may be expanded to 40 in., so that the standard size supporter will take care of any trench up to 12 ft. deep and 40 in. wide. Special models can be built for larger excavations. Any dirt which falls into the trench in front of the supporter is cleared away by a plowing device which throws this material into the path of the trencher bucket. A rear apron or shoe made of detachable 4-ft. sections is provided in which the pipe is laid. Transportation from job to job is by means of two-wheel trucks at each end of the machine, which will travel at a speed of 2 miles per hour on the road.

LOWERING TRENCH SUPPORTER INTO DITCH

Bulldozer Adjustable to Many Positions

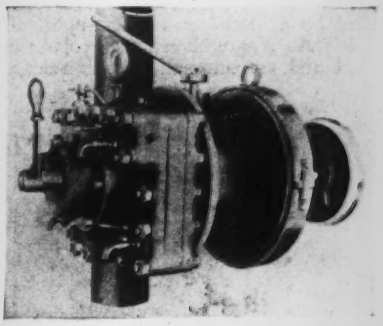
Flexibility in adjustment and ease in detachment are features of the new bulldozer and straight-blade snow plow recently developed for model 20 or 30 Cletrac tractors by the Acme Road Machinery Co., Frankfort, N. Y. The equipment is so arranged that the blade can be adjusted angularly either way so that material can be rolled to either right or left. The blade itself can also be adjusted for cutting or dragging, or one end can be raised higher than the other in what is called a ploughing position. The blade is held in place by a supporting framework fastened to the tractor by eight bolts. Its weight is balanced by a long coil spring on each side of the machine. Although the entire framework can be detached, it is usually sufficient simply to remove the blade, leaving the supporting members in place, when the tractor is desired for other purposes.



BULLDOZER ATTACHMENT FOR TRACTORS

Air-Steam Hoist Improved

Improved engine design with balanced pistons and air control through balanced spool valves with increased port areas give greater efficiency to the new model 8 Leadville single-drum air or steam hoist recently announced by the Gardner-Denver Co., Denver, Col. This model is rated at 6 hp., with a rope pull of 2,000 pounds at a speed of 150 ft. per minute. The drum is 6 in. in diameter by 9¼ in. wide with a capacity of 620 ft. of ⅝-in. rope. All moving parts are fully inclosed, with gears in dustproof, oiltight cases. Brakes are of the post type, operated with a long lever. A non-destructive clutch connecting and disengaging the drum from the gear set is operated with a lever. Crank shafts of heavy forged ground steel run in ball bearings. Gears are made of steel with cut teeth and are heat treated.



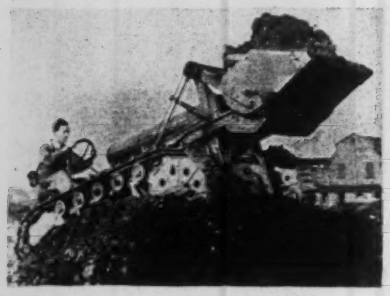
HOIST OPERATED BY STEAM OR AIR

Hoist and Shovel Attachments for Tractor Mounting

Two new attachments for mounting on McCormick-Deering tractors have been developed by the Trackson Co., Milwaukee, Wis., comprising a single- or double-drum hoist and a shovel. The hoist may be mounted on either a wheel tractor or a crawler unit, and is also available as a stationary hoist. Features of the machine include large cable capacity, screw-type clutches, oversize drum shafts, hand lever control and ready adaptability from single- to double-drum type. The auxiliary drum may be attached as the user needs it without any alteration to the main drum unit. The hoist is mounted on the tractor by means of 6-in. steel channels which connect the front of the hoist and the tractor rear housing. The main drum is 8 in. in diameter and 17 in. between flanges; the auxiliary drum 9 in. in diameter and 17 in. between flanges. Drive is through a roller chain of 1¼-in. pitch. All high-speed shafts

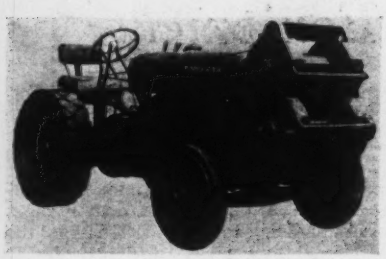
turn in SKF and Hyatt bearings, while extra-large bronze bearings are used for the drum shafts. On the tractor-mounted model the clutch is a friction cone, actuated by an improved thrust screw through thrust ball bearings. On the stationary hoist the clutch is of the dog type, transferring the power from the main drum shaft to the elevator spool. Standard equipment on both models is a Gypsy spool mounted on the left end of the main drum shaft.

The Trackson shovel consists of a bucket 46 in. wide made of ¼-in. steel plate, with a capacity of ½ cu.yd. water level. It is equipped with a cutting edge of special cast steel and is controlled by a mechanical clutch-operated hoist. A single lever controls the bucket and an automatic clutch release



DIGGING WITH SHOVEL ATTACHMENT

eliminates any possibility of raising the shovel too high. A special feature is the bucket return, which is either power operated or automatic. The machine has a lifting height of 40 in., a dumping clearance of 25 in. and an over-all height of only 69 in. The assembly is mounted on a McCormick-Deering model 20 tractor with either wheels or

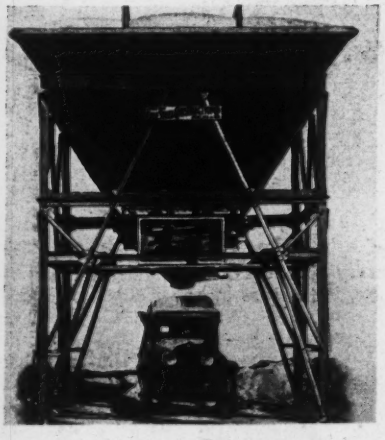


DOUBLE-DRUM TRACTOR-MOUNTED HOIST

crawler threads by means of main side frames made of heavy structural steel supported only at the front and rear of the tractor, which merely serves as a power plant and is relieved of all shocks to which the excavating equipment is subject. Power from the tractor motor is transferred to the hoisting assembly by means of a roller chain drive and a multiple dry disk clutch. The bucket dump is foot operated and adjustable for various materials and dumping grades. Digging range varies from 8 in. below ground level to 40 in. above.

Batching Plant for Loading Mixer Trucks

Elevated aggregate proportioning plants for loading various types of mixer trucks are now being made by the Erie Steel Construction Co., Erie, Pa., with two, three and more compartments of 25 tons capacity and up, for loading trucks of ½- to 3-cu.yd. capacity. These units consist of a self-cleaning bin, a self-cleaning weigh-



PROPORTIONING AGGREGATE INTO CEMENT TRUCKS

ing aggremeter and a floating charging hopper. Each class of material is weighed on a separate beam, with an auxiliary dial to show the approach to the desired weight. Hand wheels control the operation of the bin gates and a trip rope opens the draw-off door, which closes automatically. It is claimed that weights can be secured to within 1 lb., assuring uniform batches. The charging hopper is so arranged that it can load trucks from the end or from above.

Costs and Contracts

E. N.-R. Index Numbers

Cost			Volume		
Feb. 1, 1930	**206.46**		**January, 1930**	**199**
Jan. 1, 1930	208.96		December, 1929	166
Feb. 1, 1929	210.40		January, 1929	325
Average, 1929	207.02		Average, 1929	317
Average, 1928	206.78		Average, 1928	287
1913.....	100.00		1913.....	100

This Week's Contracts

Heavy construction contracts, reported by *Engineering News-Record* in the week of Feb. 27, with some comparisons, total as follows:

(In Thousands of Dollars)

	Feb. 27, 1930	Feb. 20, 1930	Feb. 28, 1929
Buildings:			
Industrial.....	$7,806	$3,165	$5,168
Commercial....	32,754	42,113	59,011
Streets and roads.	3,388	12,629	4,498
Other eng. constr.	12,213	18,244	23,659
Total.....	$56,161	$76,151	$92,336
Total, all classes, Jan. 1 to Feb. 27:			
1930.....			$434,155
1929.....			761,616

Business Notes

WELLMAN ENGINEERING CO., Cleveland, Ohio, is the new name assumed by the Wellman-Seaver-Morgan Co., following action by the shareholders at the annual meeting held recently.

W. A. RIDDELL CO., Bucyrus, Ohio, has sold its Little Rock (Ark.) branch to the Southwestern Equipment & Supply Co. O. E. Tapley, formerly in charge of this branch, will serve as field representative of the company in Arkansas and adjacent territory.

SIVYER STEEL CASTING CO., Milwaukee, Wis., and NUGENT STEEL CASTINGS CO., Chicago, Ill., have consolidated. The combined organizations will function under the name of the Sivyer Steel Casting Co., with the home office located in Milwaukee.

GOODER-HENRICHSEN CO., INC., Chicago, contractor for shoring, underpinning and moving buildings, reports the appointment of N. B. MacNeely as vice-president. Mr. MacNeely was formerly with Joseph T. Ryerson & Son, Inc., and the General Fireproofing Co.

CHICAGO BRIDGE & IRON CO., Chicago, Ill., has purchased the Reeves Brothers Co. plant at Birmingham, Ala. It is located on a 40-acre tract, which was included in the purchase, and has a capacity of 4,000 tons per month. This plant will be used by the Chicago Bridge & Iron Works to fabricate steel for erection at Southern points, for shipment to the Pacific Coast by water and as additional facilities for handling export work.

WALLACE W. DUPRÉ, for fourteen years sales manager of the Knickerbocker Co., Jackson, Mich., has purchased an interest in the business of Thomas Brown, Inc., Baltimore, Md., and Washington, D. C., equipment distributor, and will make his headquarters in Baltimore. He retains his interest in the Knickerbocker Co., remains as its vice-president and will give his general attention to the company's Eastern sales.

PENNSYLVANIA PUMP & COMPRESSOR CO., Easton, Pa., in addition to its regular line of single-stage, double-suction centrifugal pumps with spherically seated bearings, is now offering ball-bearing type pumps suitable for capacities up to 1,000 gal. per minute against heads up to 300 ft. The company also announces the appointment of a new representative in the Cincinnati and Louisville districts: the Kring-Becker Engineering Co., Cincinnati, Ohio.

STACEY ENGINEERING CO., Columbus, Ohio, now controls the following organizations: P. H. & F. M. Roots Co. and the Connersville Blower Co., Connersville, Ind.; Wilbraham-Green Blower Co., Pottstown, Pa.; and the Stacey Brothers Gas Construction Co., Cincinnati, Ohio. All companies involved in the merger will maintain their separate identities and organizations and will continue to operate separately until final plans of the merger can be consummated.

P. H. & F. H. ROOTS CO., Connersville, Ind., announces the election of Carmi A. Thompson as president, Corwin Abbott vice-president and general manager, Fletcher S. Heath vice-president and Erle G. Meeks secretary and treasurer. E. D. Johnston has resigned as president of the company and has retired from active business.

CONNERSVILLE BLOWER CO., Connersville, Ind., announces that John T. Wilkin, president and chief engineer, will also act as general manager of the company. Bernard C. O'Brien, formerly in charge of sales in Pittsburgh, is now secretary; W. E. Newkirk, formerly purchasing agent, is now treasurer; and E. C. Hassler, assistant superintendent, has been appointed acting superintendent.

UNIVERSAL ATLAS CEMENT CO., Chicago, Ill., has made the following appointments: E. D. Barry, formerly superintendent of the plant at Universal, Pa., and Leonard Wesson, formerly assistant general superintendent, Atlas division, are now assistant operating managers, with headquarters in Chicago; J. C. Witt, chemical engineer, is transferred from Buffington, Ind., to Chicago; T. A. Hicks, general chemist, Atlas division, is appointed to the same position with the new company, with offices in Chicago; R. L. Slocum has been advanced from assistant superintendent to superintendent of the Universal, Pa., plant; H. H. Lauer, engineer, Atlas division, is assistant chief engineer, with offices in Chicago; Gordon Huth, safety inspector at Duluth, Minn., is now safety director for the company, with headquarters at Chicago.